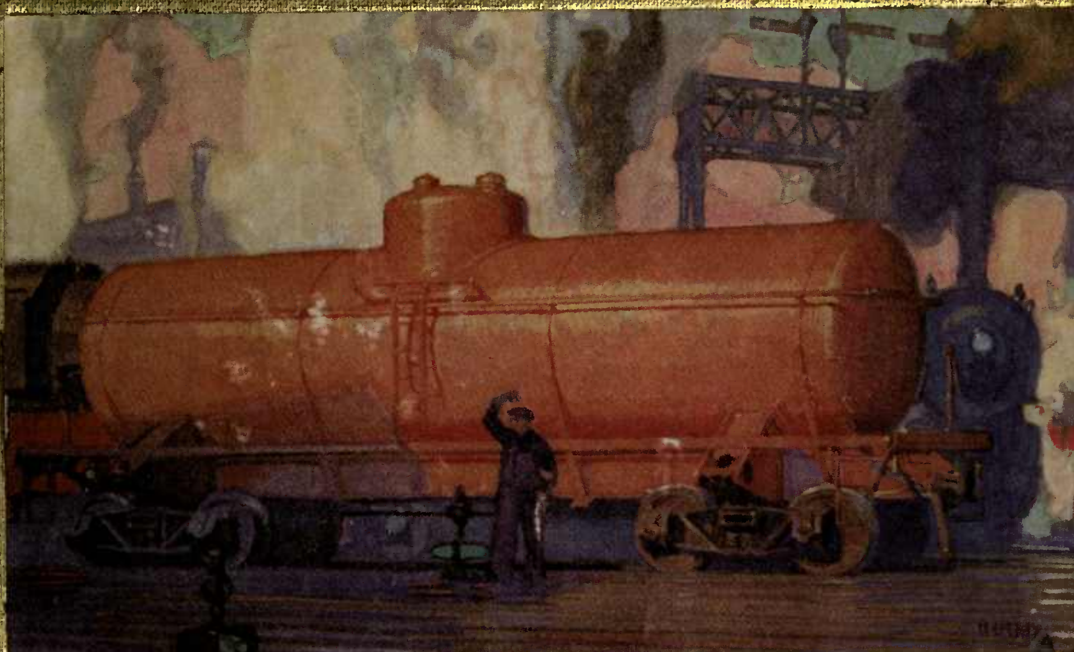

Standard Tank Car Journeys

WHERE INDUSTRIAL LIQUIDS
COME FROM AND WHERE THEY GO

Emanuel Fritz, 1921.

Standard Tank Car Journeys

Where Industrial
Liquids come from
and where they go

Standard Tank Car Company

Offices:

New York — Woolworth Bldg.
Pittsburgh — Union Arcade Bldg.
St. Louis — Arcade Bldg.
Chicago — Peoples Gas Bldg.

Works: Sharon, Pa.

A STANDARD TYPE STANDARD TANK CAR

The worth of this car is expressed in the slogan, "Built for a purpose and not for a price." The strength, the durability and the refinements that adapt it to various uses make the Standard Tank Car the standard of liquid common carriers.

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P R E F A C E

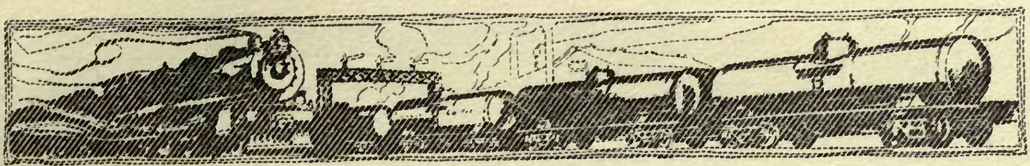
"Standard Tank Car Journeys" is a sequel to "All About Tank Cars."

The earlier book is a guide that should be at the elbow of every tank car lessee and owner; it includes detailed specifications for all types of tank cars, full information on mileage earnings and tank car accounting, the text of the Master Car Builders and government requirements, and much other detailed and general information one should have to secure the most economical and satisfactory operation of cars.

"Standard Tank Car Journeys" takes in a broader field. It is a non-technical account of the parts played in industry by the many commodities handled in Standard Tank Cars—and tank cars in general. It is presented as an interesting and instructive treatise on the vital service of tank cars, with the hope that each and all of us connected with the wide and important employment of liquids in industry may gain a clearer view of our functions as they are related to the work of the nation and the world, and secure some larger measure of inspiration from our daily tasks.

New York, Pittsburgh, St. Louis, Chicago

Prepared and written by
D'Arcy Advertising Company
St. Louis



INTRODUCTION

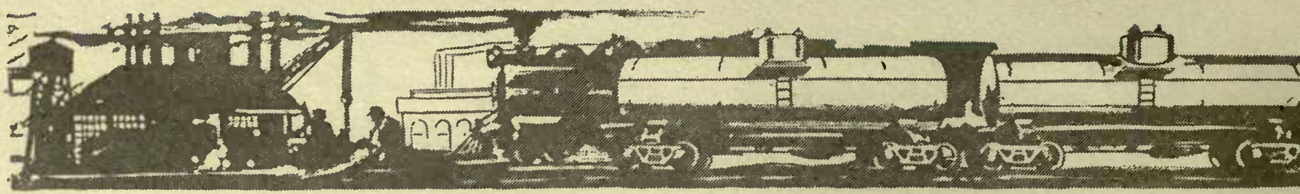
The Service of the Tank Car

THE man who wants to know what the industrial world is doing today, with the new post-bellum vision before us, could not get a Cook's guide, but he can find a directory to the vital spots no less accurate than the sophisticated gentlemen who lead our school girl parties to the Old World seats of history, romance and art. The itinerary, covering the whole country, would be traced in the journeys of the railroad tank car.

It is remarkable how one unit in our vast industrial system can so closely weave itself into the warp and woof of the whole. The tank car, the common carrier of liquids, is as vital in its sphere as the coal car is to the activities it serves. Moreover, the tank car has in its construction such engineering features as prohibit substitutes—placing it in this respect in a class among railway transports comparable only to refrigerator cars for perishable foodstuffs.

Just as to know American industries one must follow the tank car, to know the tank car one must consider the industries.

Obviously, the first on the list is the petroleum industry. This industry brought the tank car into existence and caused



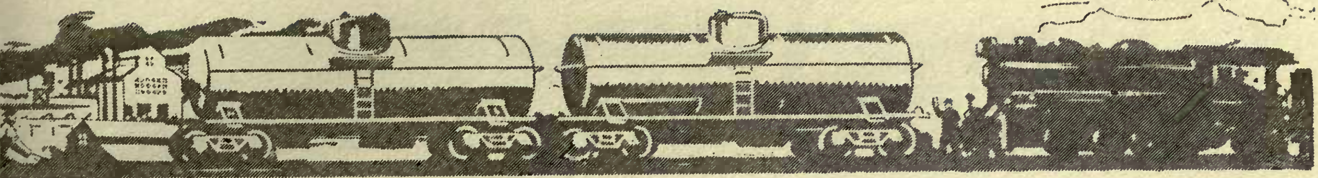
its development to its present perfection. Its demands have had a tremendous effect on the growth of other liquid industries and, through its employment of the tank car, it revealed to all of them efficient methods of transportation.

The petroleum industry feeds power to innumerable motors that have revolutionized civilized life, turns the evening into lighted hours in even the remotest abodes of mankind. It lubricates the world's machinery, supplies fuel to giant furnaces and engines on land and to the ships of our Navy and Merchant Marine, and provides an ever increasing number of products for various benefits—all made possible largely through the efficiency of the tank car.

Do you know the story of how millions of dollars annually were wasted in cotton seed before the manufacture and uses of cotton seed oil were developed? This valuable oil, now the base of many foods, is brought to market in the tank car, an 8,000 gallon tank car being the standard of measure of quantity on the Eastern Market.

Cotton seed oil is but one of many valuable vegetable oils with which the tank car serves industry.

Manufacturers of paints and varnishes, weavers of silk and fine cotton goods, producers of soap, makers of roofing, builders of streets and roads, tanners of leather, foundries and rolling mills and a long list of other industries depend upon the tank car to deliver to them the necessary quantities of commercial liquids.



The tank car is handling more and more foodstuffs, including molasses, wine, vinegar, pickles, skimmed milk and water.

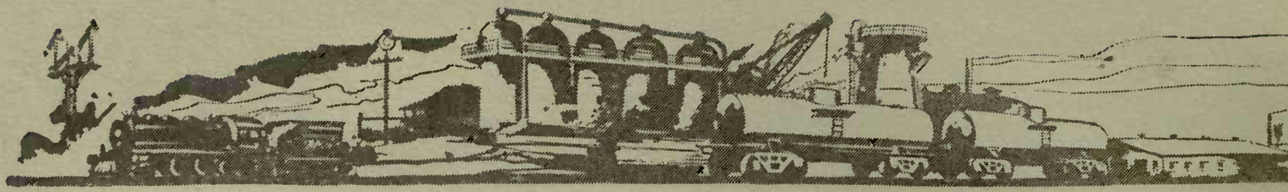
You can point to scarcely a manufactured article about you that the tank car has not had a part in the making of. Take the glass in the window before you. The tank car carried the sulphuric acid and other ingredients that went into its making. The printed sheet before your eyes—rosin and linseed oil, shipped in the tank car, helped make the paper and the ink.

Chemistry, which has played such a dominant part in the development of petroleum, has built an industrial world with other products—acids, salts and alkalies. Through the mastery of the tank car over dangerous liquid chemicals, industrial America is served with many of its primary ingredients.

America no longer is dependent on the old world for aniline dyes. By-products from coal have given these materials and many other commodities that are essential to many manufactories, and you must have the tank car to transport coal-tar and its distillates.

The tank car's use is measured by industry itself. Its influence does not stop with the cities but touches every town and hamlet, even the most isolated farm. America's dependence on the tank car is far greater than most men realize.

Just suppose for a moment that the tank car was eliminated.



Some years ago an impending strike of coal miners in England threatened a parallel case. The late William T. Stead, famous English journalist, cabled a dispatch to American newspapers which began with this terse sentence:

"England today is on the brink of Hell."

English industry could not live without coal and the nation could not live without its industries. Just so with the tank car—there would be a stopping of wheels and a halting of manufacturing and business if the tank car did not "carry on."

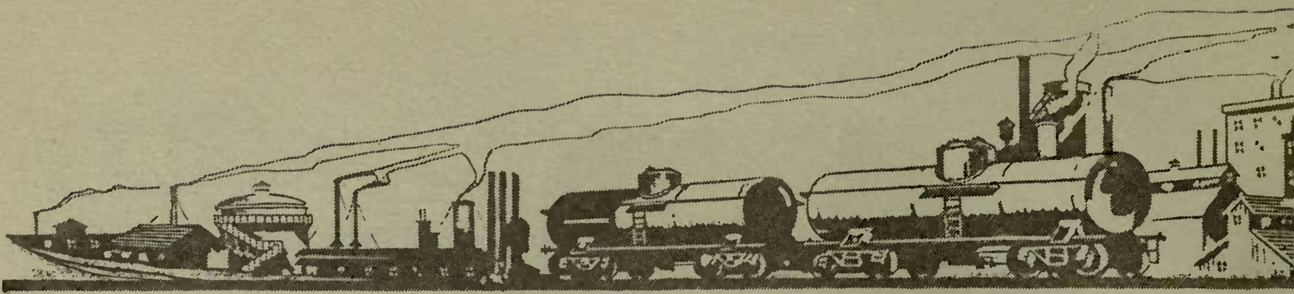
The future of the tank car is great as the futures of the petroleum industry, industrial chemicals, vegetable oils and the great kingdom of industrial liquids are great; for the tank car is not of that class of machinery which time soon makes obsolete. Fundamentally, the tank car is as stable as the box car; and as it has been adjusted to meet the peculiar requirements of each industry it serves, so it improves with each new demand for it.

The consciousness of the scope of this vital service is expressed in the engineering and mechanical perfection of Standard Tank Cars. Adjustments adapt them to the whole wide variety of liquid transportation—always with reliability.

"Standard Tank Car Journeys," while a study of the use of tank cars in general, actually is an account of the employment of Standard Tank Cars. Every industry requiring modern liquid transportation has commanded the study and

effort of the Standard Tank Car Company to supply its particular need.

The journeys are many, each with its own distinct interest—where the various commodities come from and where they go. Glimpses of each of the separate routes finally combine to form the full and complete picture of the services of Standard Tank Cars—a picture that tells the story of tank cars in general.



CHAPTER I

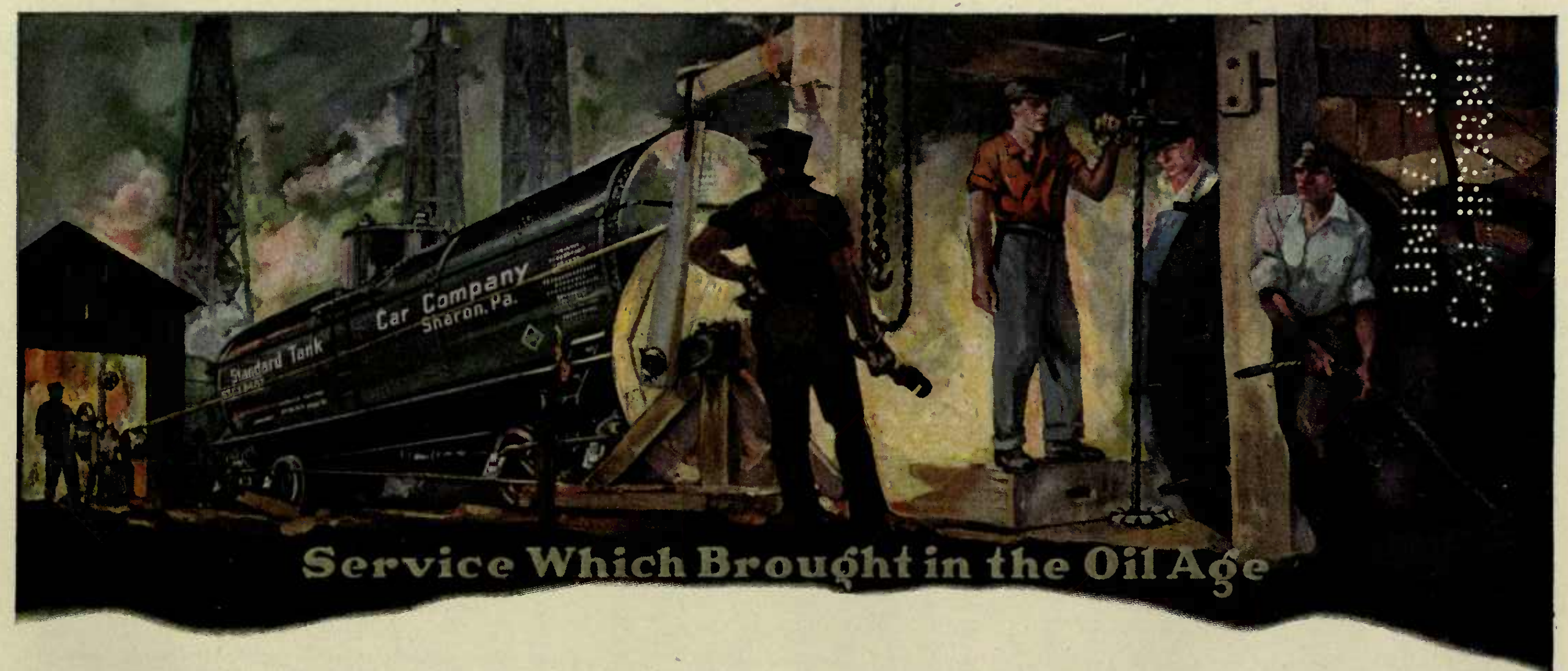
Petroleum

History of Petroleum and its Products, Tracing the Development of their Uses—Occurrence of Petroleum in the United States and Foreign Countries

THERE is no magic in the "Arabian Nights" like the true story of petroleum. Known since the beginning of recorded history, it remained for our own time and largely to our country to win its great wealth and speed industry into what many term the "Oil Age."

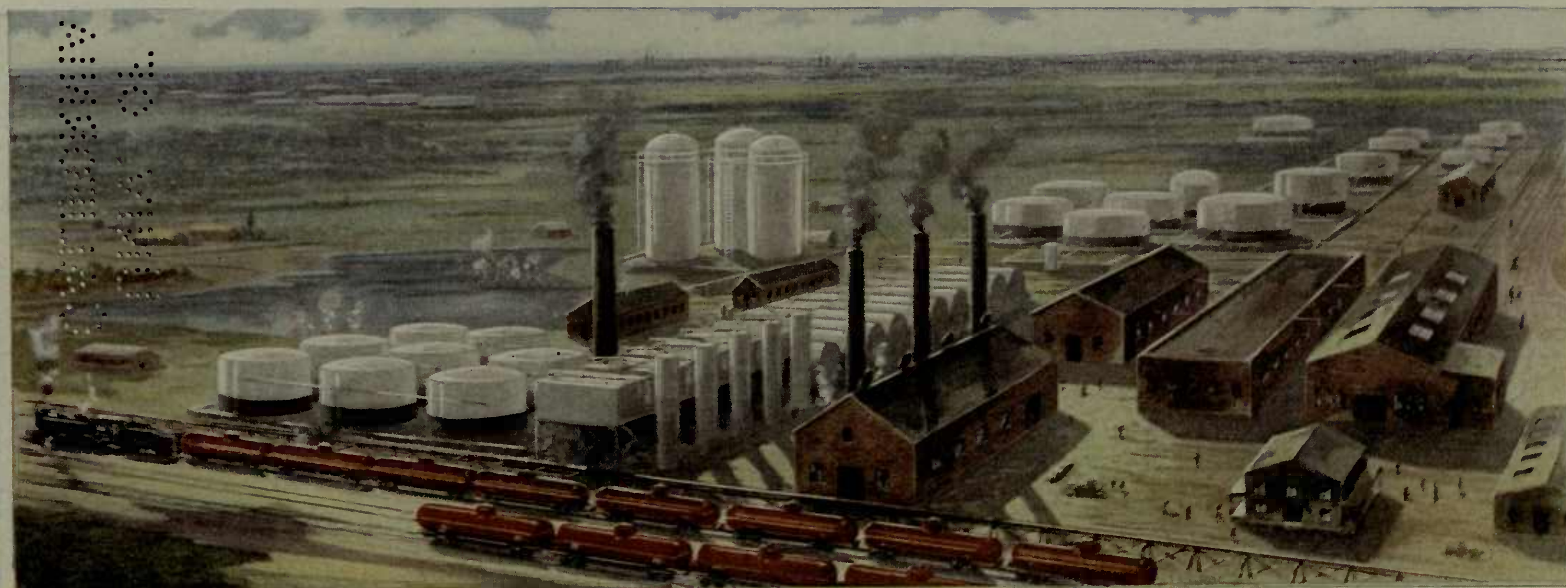
Petroleum has relieved human hands of much onerous toil and provided many delights that are personified in the motor boat and the automobile. Yet the thought that grips the imagination strongest is of the huge fortunes that come to those who discover the great reservoirs of crude oil that are hidden deep down in the crust of the earth.

We learn of the ancient history of petroleum from Herodotus, who refers to the oil pits near Babylon, and from Pliny, who mentions illuminating oil from Sicily. The ancient Chinese and Japanese used it for heating and lighting and for medicinal purposes, calling it "burning water." The American Indians knew of its possibilities as a fuel



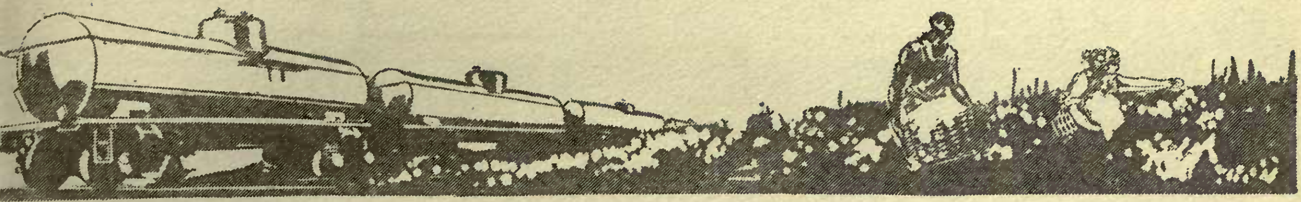
SERVICE WHICH BROUGHT IN THE OIL AGE

More than 60,000 tank cars are employed in the petroleum industry. The first was invented and introduced in 1871, and from that date tank cars, pipe lines, the drilling method in mining and distillation in refining have composed the four vital elements in the industry.



THE ARTERIES WHICH DISTRIBUTE FUEL, POWER AND LIGHT

From where gigantic refineries purify and render available liquid resources of the earth, the tank car bears fuel, power, light and lubricants into every corner of the continent—closely paralleling the function of the arteries of the body.

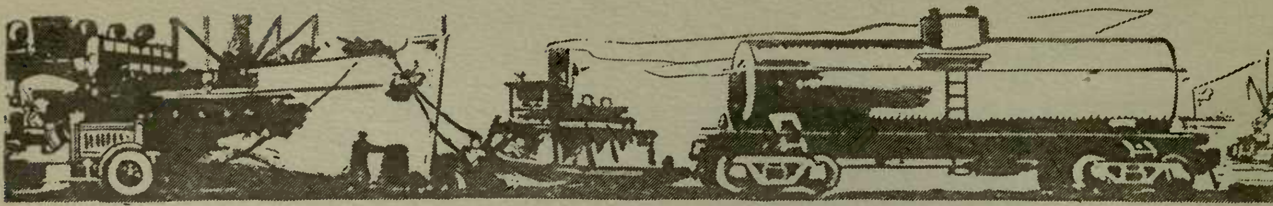


and used it for healing purposes 300 years ago, securing their supply by skimming pools and creeks. But time made little impression on its use until the latter half of the nineteenth century.

The swift movement of the industry to its present state is shown most graphically by what it has done to some of the ancient race of Red Men who first discovered the oil in America. An example is the Osages, who were shipped to a reservation that now is a part of Oklahoma. A tribe of more than 2,000 draws an annual royalty of more than $5,000 each from oil lands that have been leased through the government.

Geological science, which now speaks with authority on the sources of petroleum, played a minor part in the discovery of most of the world's supply. Chance, the spirit of adventure and common sense, those qualities that have given the white man dominion over the earth, revealed the great oil fields. The conflict between the two viewpoints continues today, for while geologists claim that the sources are limited and rather clearly defined, especially in the United States, many successful oil men believe that before many years oil will be discovered in every State in the Union.

As to the origin of the oil, the explanation of the geologist prevails, though the subject long was in dispute between scientific minds. The theory is that petroleum is the product of distillation within the crust of the earth of marine organisms, sometimes vegetable and sometimes animal, and under normal temperature and pressure. These organisms sank in death, perhaps millions of years ago, to the bottom of the

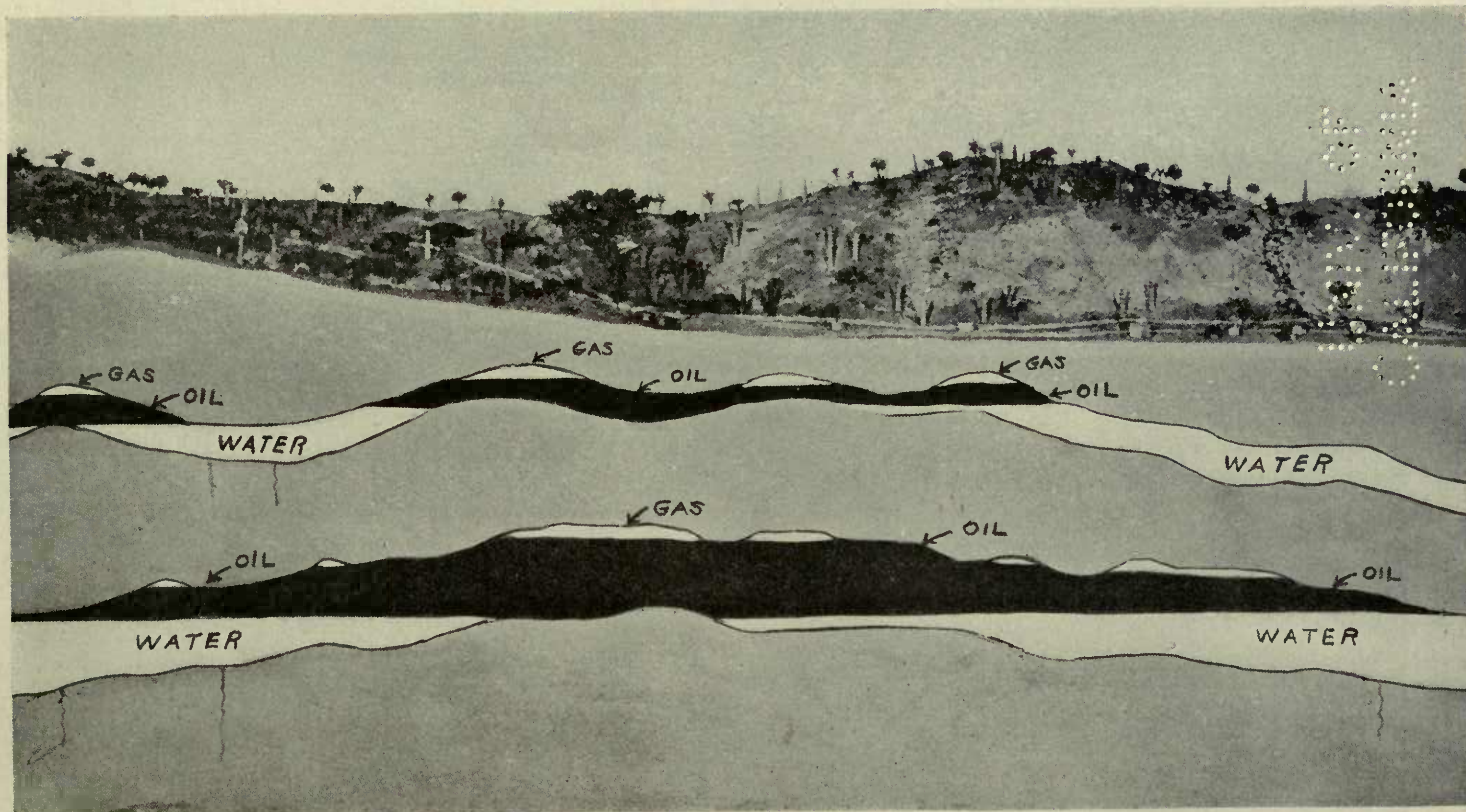


sea and under the pressure of water were covered over with ooze and sand. Through the centuries they decomposed and were distilled. The great geological changes in the crust of the earth raised sea bottoms to wide plains, upheavals made mountains and valleys.

The great pressure from these changes forced the oil from the rocks and sand where it was absorbed and made pools of it.

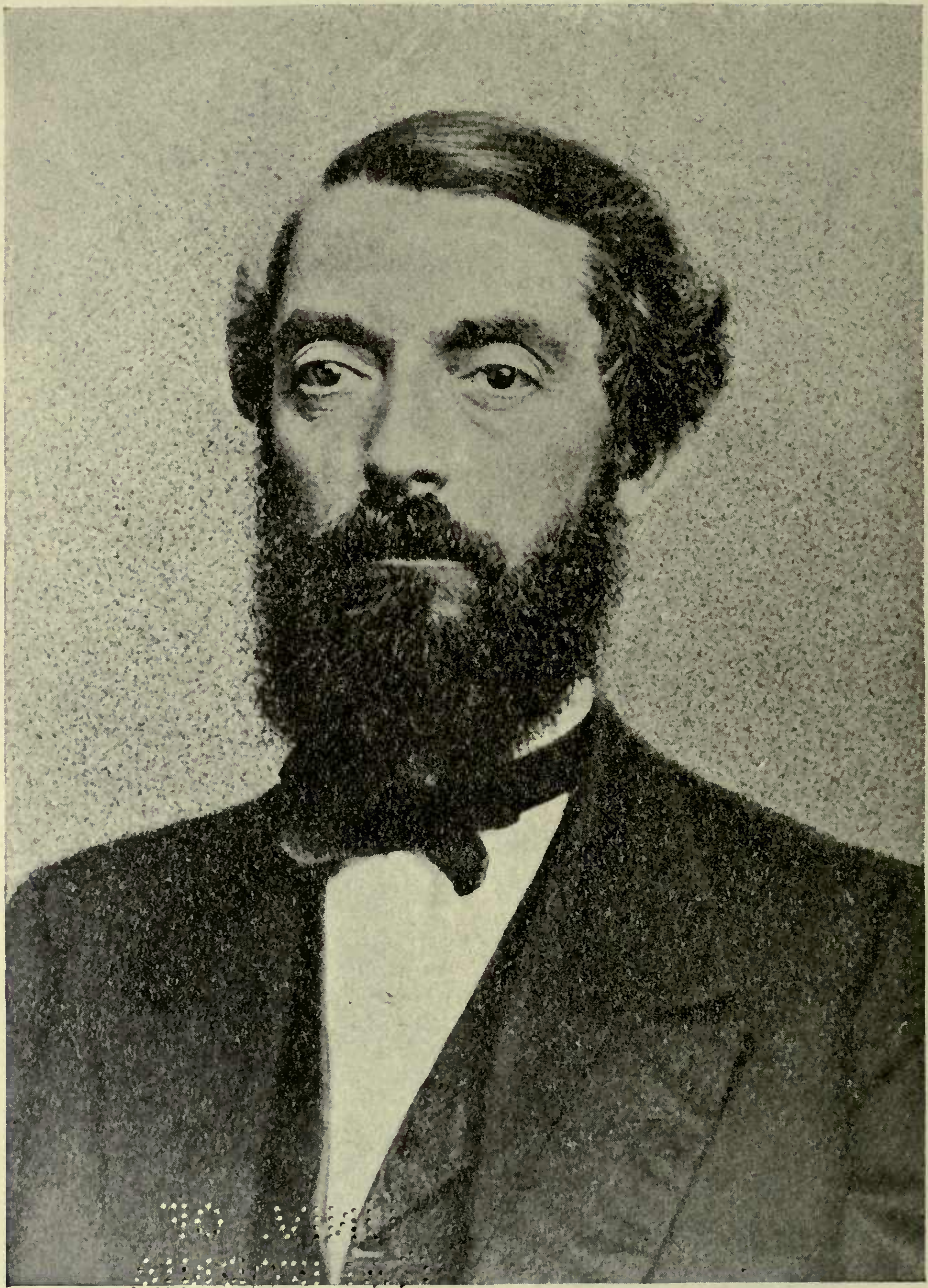
The force of gases from the liquid caused great pressure on the walls of these subterranean pools and the first discoveries of petroleum were the result of oil oozing out on the earth's surface. Even great pools were laid bare to the sky, as evidenced by the Trinidad asphalt lake. This wonderful lake, scientists tell us, is a petroleum pool from which the volatile oils have evaporated.

A point of more human interest is a means of discovering petroleum deposits that have not revealed themselves on the earth's surface. Long ago the known oil fields have been taken up. The rapidly increasing demand for the oil and its products have shifted the opportunity of large profits to the discovery of new fields. Geologists have evolved the theory of "anticlines and synclines," by which oil is located in anticlines. The anticlines do not reveal themselves to the layman eye, but they are what once were mountains that time has eroded. A study of the rock formations identify them, the anticlines being the stumps of former mountains and the synclines the valleys. The oil is in the anticlines because gravity forces it above water that extends to the



VIEW OF THE OCCURRENCE AND MINING OF OIL AND GAS

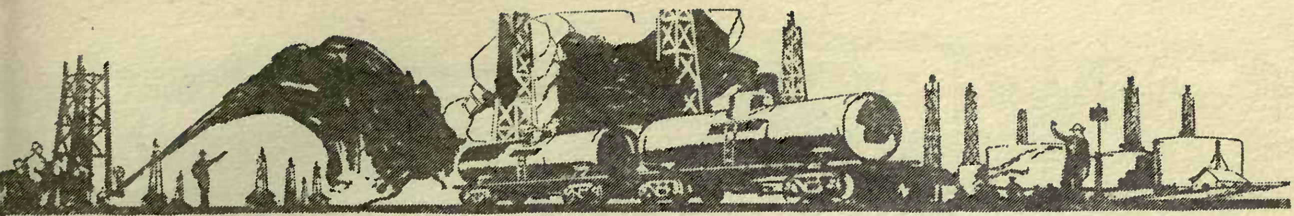
Photograph of a model in the Division of Mineral Technology, United States National Museum.



Courtesy of Oil News, Chicago.

COL. E. L. DRAKE

The man who drilled the first oil well and who now is honored with anniversary celebrations by oil men.



synclines. Often several pools exist one beneath the other, separated by strata of sand and rock.

The first reference to petroleum in America was an observation of its use by the Indians by a Franciscan missionary in 1627. After collecting it from the surface of creeks and pools, they boiled it in kettles and used it as a cure for sprains, swelling and rheumatism. What the white man did about it is not known until 1826, when it was collected in a manner similar to that of the Indians, strained through woolen fabrics, and used on sores in the manner pointed out by the Indians.

The value of the oil grew rapidly in appreciation. The knowledge of the ancients that it was suitable for illumination was rediscovered, and crude processes of refining and purification were evolved. Along Paint Creek, Johnson County, Kentucky, they dug shallow canals to catch the sand and water from the creek and got the oil from the top by stirring the flow with poles. Efforts were made to mine the oil by hand-dug wells where petroleum was evident. Hand-dug wells played an important part in its early industry in Russia and Rumania. In Rumania they sunk wells of this type, which were some five feet in diameter, as deep as 450 feet. The oil was baled out in earthen and leather vessels by means of a windlass.

Simple methods of refining that were in practice before the dawn of the eighteenth century were greatly improved before the real beginning of the oil industry. The Cossacks distilled the product from the Caucasus before using it for

combustion. Crude petroleum was experimentally distilled in the United States in 1833. An insufficient supply of the raw material was the great drawback, and to get supplies of illumination oil, a considerable industry in distilling coal, or shale, oil was developed on Long Island.

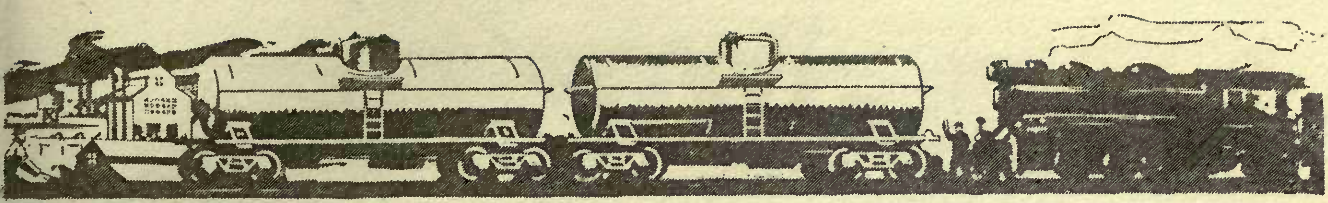
The impetus to the modern industry came in 1859, when E. L. Drake, a railroad conductor from New York, went out prospecting in Pennsylvania and struck oil in a well on Oil Creek.

Drake employed the plan of modern drilling. He had sunk a well 69 feet when suddenly the tools dropped into a crevice. The crevice was a pool of petroleum, which for a time produced 25 barrels a day but rapidly declined. Nevertheless, he opened the way to the great supply, and from that date the industry has grown and still is growing by leaps and bounds.

The following table gives an idea of the progress in supplying crude petroleum in the United States:

1859	2,000 barrels
1869	4,215,000 barrels
1879	19,914,146 barrels
1889	35,163,513 barrels
1899	57,084,428 barrels
1906	126,493,936 barrels
1918	345,500,000 barrels

There has been no hit or miss policy in refining petroleum and applying it to usage. Here science, especially chemistry, has held undisputed sway, expanding its market with



the progression of the years so that nearly always, as particularly today, the supply has been below the demand.

Its first use as a medicine still is approved by physicians in the wide employment of "Vaseline," a salve, and "Nujol," a clear liquid for the treatment of constipation. Similar products to these have a wide application in medicine.

Next came its use as an illuminant. Drake's discovery virtually put the coal oil industry out of business, but the shale oil machinery was adapted to handling petroleum and served as the forerunner of modern refineries. This early method of providing illumination oil caused kerosene for a long time to be called "coal oil." For forty years kerosene served as the principal petroleum product. There is no finer commentary on American business than the world-wide use of American kerosene, extending to the remotest parts of China and India. Wherever the traveler may roam he will find the tin container, frequently adapted to various domestic uses, showing that the American oil merchant has preceded him.

Along with the manufacture of kerosene was the production of lubricants. Some of the more viscous oils were suitable as lubricants without refining. Refining and further treatment quickly brought them to the point of industry's principal supply of lubricants. Today it virtually would be impossible to provide suitable substitutes. Vegetable and animal oils thicken and rust with use, serving satisfactorily in most machines only when blended with petroleum products. A moment's reflection on this phase of petro-

leum's usefulness is illuminating. Proper lubricants are as vital to modern industry as the power that drives the wheels.

It was obvious from the beginning that petroleum was suitable as a fuel. The difficulties of providing a uniform fire were overcome by the invention of oil burners, by means of which the crude oil, and later the heavier oils from the refineries, were sprayed into furnaces by steam or compressed air. Oil fuel saves labor in firing furnaces and adds to convenience. Oils are more easily transported than coal. In certain parts of the country, particularly the Southwest and California, coal was inadequate and inaccessible to the industries that have grown up. Because they give to warships the maximum fuel, which tends to high speed and more effective range of action, fuel oils have come into great use in the navies of the world. Our late dreadnaughts are oil burners. In the construction of our Merchant Marine the future of fuel oils is expanded. To the other advantages is added the reduction of crews and availability of greater space for cargoes.

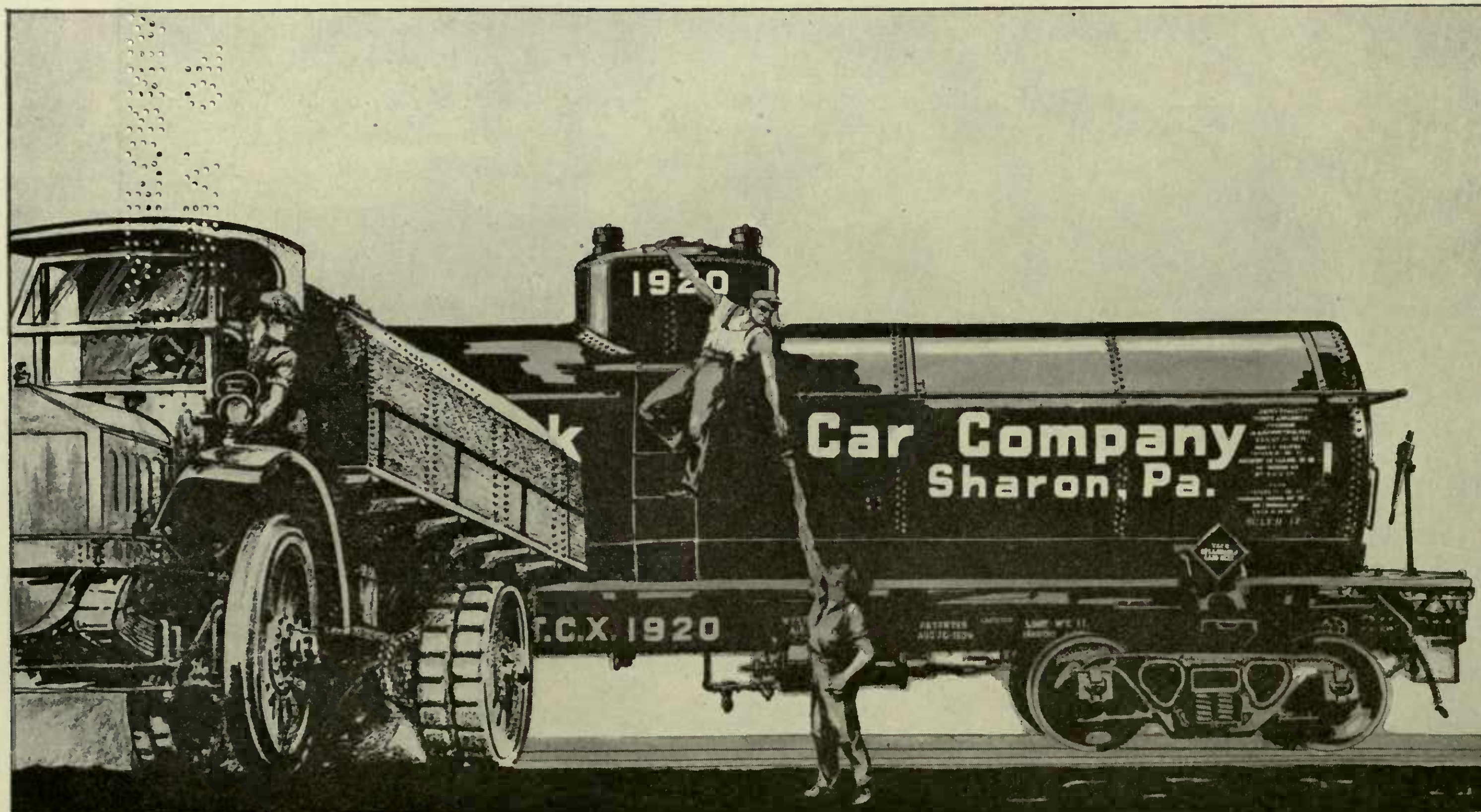
Something of what the future still holds is indicated by the growing use of the crude oil engines, which use plain petroleum in internal combustion.

The possibilities of illumination, lubrication and fuel from petroleum had been grasped and applied before the greatest present demand of petroleum was understood—that of gasoline. Most encyclopedias and dictionaries that we have in our bookshelves don't even contain the word "gasoline." In the earlier petroleum industry the more volatile oils were designated as naphtha. In the quantities in which

Courtesy of Oil News, Chicago.

THE FIRST OIL WELL

The well was drilled by Col. Drake on Oil Creek, Pennsylvania, in 1859. It produced 25 barrels a day for one year, although it was only 69½ feet deep. In the foreground is Col Drake, the man with the silk hat, talking to his friend, Peter Wilson. The photograph was taken by John A. Mather on August 17, 1861.



SAVING TIME IN UNLOADING TANK CARS

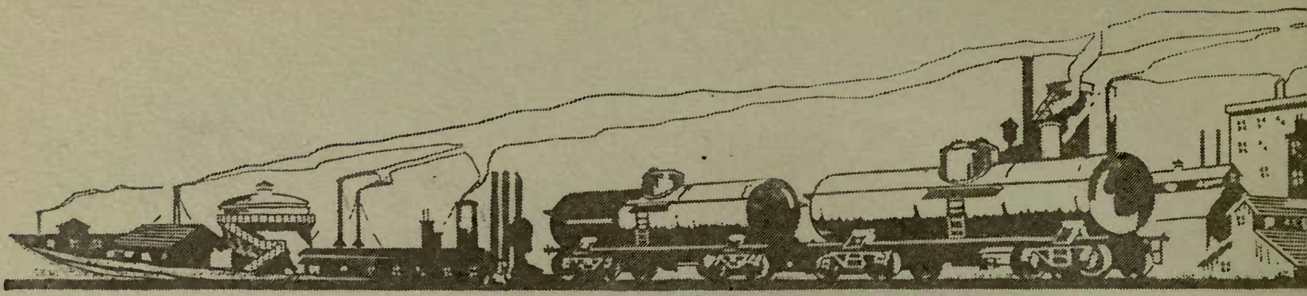
The ease with which tank cars may be unloaded is an important item in the economy of their service. Time is as much an element in transportation as distance. Tank cars travel fast and are quickly loaded and unloaded.

they came off in the production of other petroleum products they were regarded as commercially worthless, and many oil companies burned vast quantities to get rid of them.

The invention and development of the internal combustion motor transformed the industry. Petroleum is the only source of gasoline, whence comes the power for automobiles, tractors, airplanes and hundreds of other types of motors for innumerable purposes. Gasoline is a distinct component of petroleum and naphtha is the name of the next most volatile grade of oil. Means are being improved for employing naphtha and even the heavier kerosene in internal combustion motors. But when we get away from petroleum there is no other source of power for these engines. During the war, the Germans, with a shortage of petroleum, diligently sought substitutes, but neither they nor anyone else have been successful.

We have reviewed the great uses of petroleum and its products. Minor ones are numerous, increasing from day to day as scientists give more and more study to the subject. The time long since has arrived when no part of petroleum is thrown to waste. While the demand for gasoline taxes heaviest the supply, the need of the world for the other products is sufficient to keep up the maximum production of gasoline without loss on the other products. The progress of the industry has been so swift in recent years that the government has stepped in with the watchword, "conservation."

The gas from petroleum, whether from gas or oil wells, is consumed in lighting, heating and cooking. Gas oils are



used in the production of "air gas," oil gas and for the enrichment of coal gas. Gasoline is employed in cleaning processes.

The residuum from petroleum distillation is valuable. What it is depends upon the crude petroleum used, there being three distinct types, determined by the base. Some petroleums have paraffin as a base, some have paraffin and asphalt mixed, and some have asphalt. The oils of Pennsylvania and Texas have a paraffin base while those of California and Mexico have an asphalt base.

Paraffin is a wax and is used in making candles and waxing paper, in protective paints, as an adulterant in candy and chewing gum and for many household purposes.

Asphalt is employed in highway construction, the more or less pure asphalt being utilized in paving and the more oily substance being most useful as a road oil. A large amount is consumed in the manufacture of roofing.

As a final residuum a high grade coke may be obtained, which is used in making carbons for electric batteries and arc lights.

Between the source of petroleum and the consumption of its products is the petroleum industry itself. The industry is divided into three great branches—the extraction of the oil from the ground, the refining processes and transportation. The three go hand and hand together, having developed simultaneously, each supporting the other, during sixty years of strenuous history.

HELPING AMERICA FEED THE WORLD

A climax in the answer to the challenge of America's vast acres is the tractor—the engine that aids man to wrest from the soil the bounties of grain for food, fibre for cloth, and fruits of vine and tree. The liquids for the power and lubrication of this wonderful machine are transported in tank cars.

THE CAVALRY OF THE POWER PLANT

Tank cars quicken and sustain industry with mobile horse-power. They serve tirelessly with bone and sinew of steel, foraging and filling breaches at the height of the struggle. In transporting power for crude oil engines and fuel for furnaces, they have scored many a victory for steadier and cheaper production, all the way from individual plants to great central stations where electricity is generated.

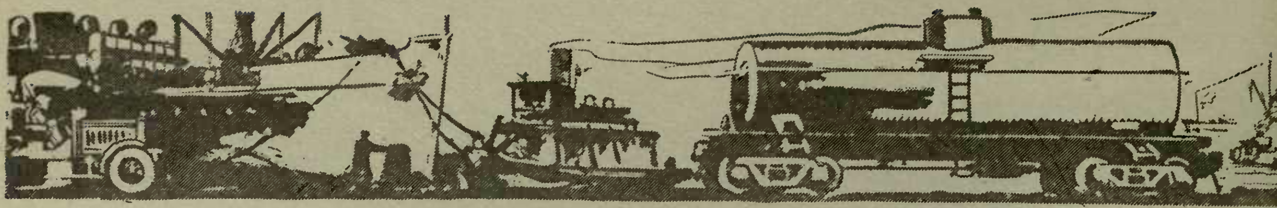
On the heels of Drake's discovery, there came into being what is now familiarly known as an oil field—a landscape studded with high tapering derricks for the suspension of the drilling rigs.

The wells are about eight inches in diameter and the first ones were drilled by the percussion method; that is, the drilling tools were suspended on a cable and a walking beam kept the tools pounding away through the strata.

The modern method of drilling is the rotary system. The debut of this system was made in Texas some fourteen years ago, and, because of its speed and efficiency, no less than 20,000 wells have been drilled with it. The system simply is a rigid stem of iron pipe rotating a fish-tail drilling bit, very much as a screw makes its way into wood.

While in the percussion system the tools have to be removed from the well to clean it, in the rotary system the pulverized strata are forced up by a stream of water reaching the head of the drill. Sometimes, when the walls of the well are likely to cave, pressure-fed mud is used in the place of the water. This mud serves the double purpose of removing the debris and plastering the walls of the well. The walls of a well always should be lined, and this is properly done with iron piping.

When a field is discovered, the landscape soon is filled with the tapering derricks. If the land is divided into small holdings, as in a town, or no restraints are imposed, wells sometimes are sunk as thick as space will permit. There are many stories in oil districts of fabulous sums being

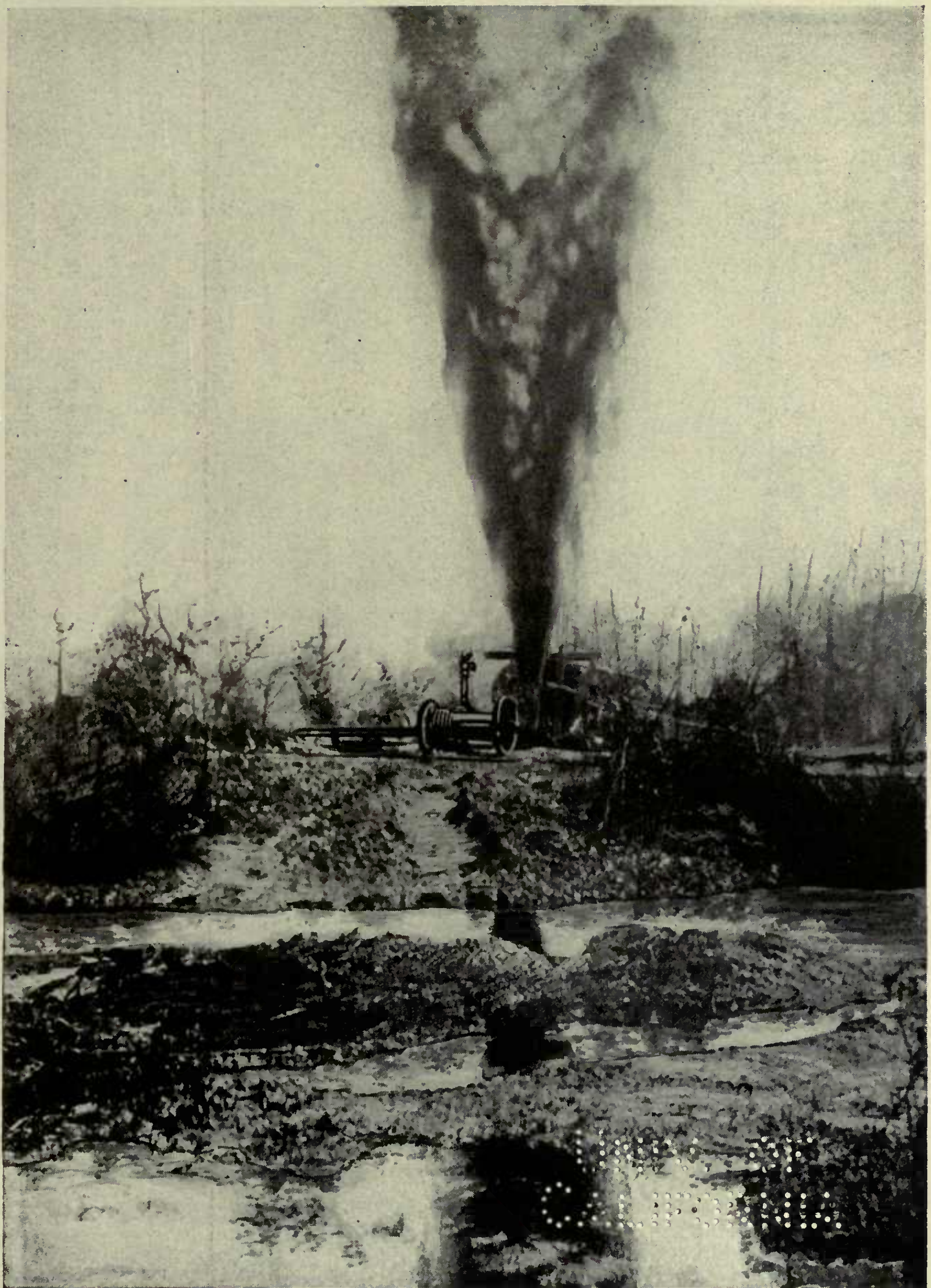


offered for small plots that were regarded as sacred, such as church lots and cemeteries. In oil towns people do not hesitate to bore wells in their own front yards. Nevertheless, authorities agree that one well to an acre is as close as they should be. The great trouble is that the proper spot for drilling can not be determined with accuracy, and the hope of winning oil often tempts men to ridiculous efforts.

The wells vary in depth from a few hundred to several thousand feet. What dramatic possibilities there are in bringing in a gusher, a well that flows out at the top, is illustrated by the famous "Dos Bocas" well which was drilled by a British company in Northern Vera Cruz, Mexico, in 1906.

The rotary drill had gone down 1,800 feet when a heavy gas pressure developed. In a few minutes a great stream of oil flung the heavy drill out and put the well absolutely beyond control. Fissures appeared in the ground some distance from the well, one opening at the fire box and starting a fire. It is said that the flames shot up to 1,000 feet in height. For fifty-eight days this "mad gusher" burned in fury, its glare being visible from many miles at sea. Millions of gallons of oil went to waste. One of the efforts to preserve the precious fluid was by building up dirt banks to hold it in ponds.

The same company brought in another well in Mexico which ranks as perhaps the largest in the history of the industry. This well, "Protero del Llano," had a daily flow of over 125,000 barrels.



OPENING A GUSHER IN THE TAMPICO FIELD

The dream of the oil miner is realized when a well flows as a gusher. It means the discovery of a rich field. Soon the area is covered with numerous wells, for the great demand for petroleum products makes a ready market for all the crude oil that can be produced.

THE TANKS THAT MAKE OUR HIGHWAYS SMOOTH FOR COMMERCE

The swift and economical distribution of goods depends upon good roads. Here again is felt the service of the tank car—the carrier of asphalt binders and road oils.

On the other hand thousands of wells have been drilled that proved entirely dry. This is the cause of the hazard in the business. To drill a deep well at the present time will cost from $50,000 to $100,000. The opportunities for striking shallow deposits yearly become more rare.

Sometimes wells produce only gas, and frequently purely gas fields are developed. The history of all producing oil wells is a diminishing supply to the point of exhaustion, the result being that in a developed field more and more wells are required to keep up the supply.

Large oil companies have sought to eliminate as much as possible the element of chance in drilling for oil. They maintain staffs of trained geologists and usually spend money for drilling only in proved fields. Drilling in unproved fields is known as "wildcatting" and, while great quantities of oil have been found through such ventures, the work is carried on largely by small operators.

Much of the drilling is done on leased lands. The deposits in the Indian reservation are worked in this way. The terms are a royalty on the oil produced.

Properly conducted oil companies have tanks built in advance in which to store the flow from a possible gusher. Producing wells may be sealed up, but someone else may tap the same reservoir a short distance away and extract much of its content. When pipe lines and tank cars to conduct the oil to a refinery are not immediately available, big iron tanks are built to store it.

In studying the exhaustion of wells, the United States Bureau of Mines has announced the conclusion that from twenty to ninety per cent of the oil in tapped reservoirs remains absorbed in rocks and sand. A practice with oil men, when a well slows down to an unprofitable point, is to "shoot" the well with explosives. Vacuum pumps and compressed air are used to increase the flow. Government investigation probably will lead to still better methods of reviving dead fields.

The early method of refining petroleum was to distill fractionally the crude petroleum, that is, the separation of its various components.

The compound petroleum is made up of gas and liquids of various boiling points. The principal liquids, in the order of their volatility, are gasoline, naphtha, kerosene, a range of lubricating oils, fuel oils and road oils.

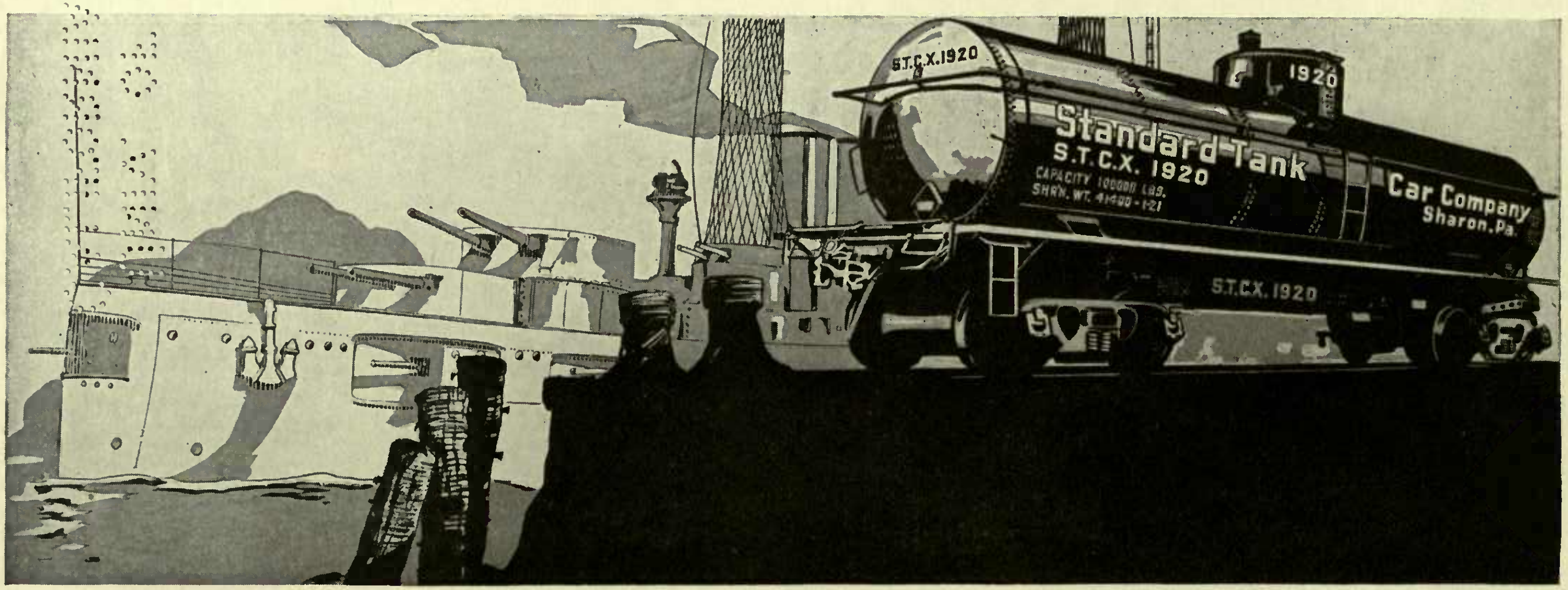
Different liquids evaporate at different rates under the same conditions. Heat speeds the evaporation. Fractional distillation is to take off the gasoline first and follow it up with the less volatile oils, the final residue being asphalt or paraffin.

Originally this distillation was accomplished in big metal stills with fires underneath. The fires greatly affected the product, causing caking of the material at the bottom of the still, so superheated steam was introduced, the steam carrying off the vapors as soon as they are freed.

The whole refining industry was revolutionized by the introduction of the cracking process. This process was dis-

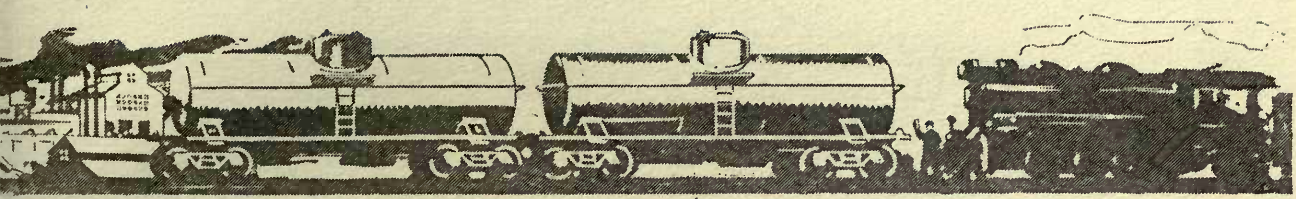
PARTNERS IN THE NATION'S PROSPERITY

Where midnight skies reflect the "burning energy" of America—where bridges are spun, rails are rolled, ships fabricated and power plants forged—the tank car, the transport of lubricants and fuel oil, plays a vitally important part.



THE MODERN WAY DREADNAUGHTS GET FUEL

The new battleships of the U. S. Navy are oil burners, because less space is required for storing fuel and fewer men can keep the furnaces going. Another advantage is the delivery of fuel in tank cars.



covered by the observation that many distillates were not the same as appeared in the original composition. The fractional distillation had caused a certain chemical as well as a physical decomposition. Through the accidental overheating of a still, it was found that distinct heavy oils were broken up into lighter oils. Since the desire of the refiner was to secure as much gasoline and lighter oils as possible, because of their higher value, the cracking process immediately was developed. Its possibilities are by no means yet exhausted.

The principle of cracking is to distill the oil in a heat greater than its boiling point. A simple application is to have the top part of a still relatively cool. As the vapors rise they strike the cool area, condense and drop back into a heat that is higher than their boiling point, and are cracked into smaller units.

There are a number of methods for applying the cracking process. One, owned by The Standard Oil Company, is known as the Burton process. Another is called the Rittman process. Their details vary, but with none of them is the refining of petroleum products completed. Gasoline and kerosene especially need further treatment.

This is done by successive treatment with sulphuric acid and caustic soda, followed by washing with water. The acid and the soda eliminate the suspended hydrocarbons, the fats, acids, tarry bodies and other impurities, the sulphuric acid removing some and the caustic soda taking the remainder along with whatever sulphuric acid has been left in the oil. Lubricating oils also are similarly treated for

adaptation to the wide variety of their usage. The oils used in medicines are products of still more delicate refining.

In the treatment of paraffin oils, there are methods of cooling and solidifying the paraffin and removing it as a wax.

An old source of waste that has been corrected was the gas that comes off as the first product of distillation. This gas is treated to take from it its gasoline content, a process that is described under "Casinghead Gasoline." The gas is then employed for heating and lighting.

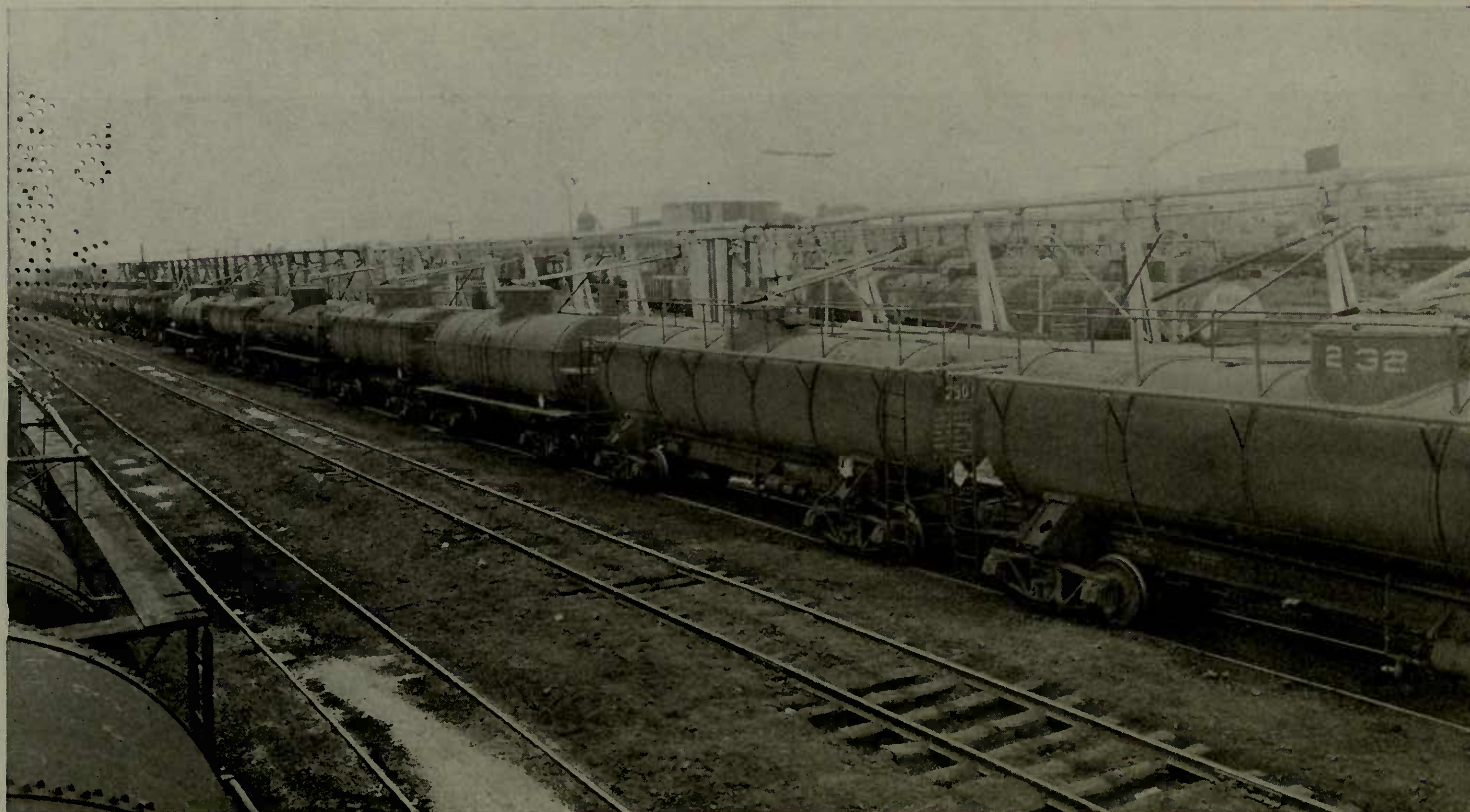
The third vital phase of the petroleum industry is transportation. It has had a bearing of no less importance than refining.

With the first development of the wells in Upper Burma, they followed the crude method of carrying the oil from the wells to the river in earthen vessels and pouring it into the holds of ships. The Russians early conceived the idea of pipe lines and built a famous aqueduct of bamboo, but the wastage from leaks soon proved it useless. The Asiatics resorted to simple man-drawn carts on which they would load oil in earthen vessels.

Transportation of oil in America passed through the stages of barrels on horse-drawn vehicles and the use of wooden containers on river barges. The lack of adequate roads greatly handicapped the horse-drawn wagons and the barges depended on freshets to swell the streams. Floating barrels of oil down creeks even was resorted to in the early days of the Pennsylvania field.

SUPPLYING INDUSTRY WITH ITS INDISPENSABLE LUBRICANT

Without lubrication every bearing and tool in every factory—every wheel that turns on highway, tramway and railroad—every piston, turbine and generator—every typewriter lever and watch pinion—would stop. The clock of civilization would be set back five thousand years. Oil production in the United States for 1919 has been calculated at 100,000,000,000 pounds of crude oil and 30,000,000,000 pounds of lubricating greases. In moving this stupendous quantity the tank car has proved absolutely necessary.



TANK CARS AT A LOADING RACK

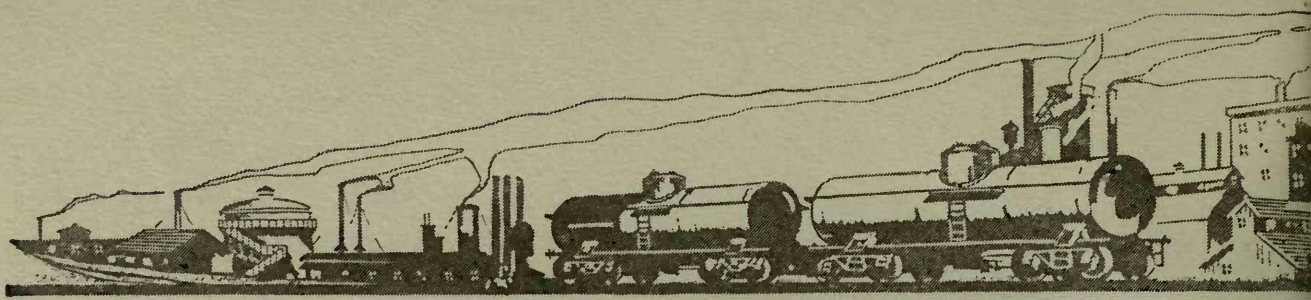
Each of this train of Standard Tank Cars may be loaded at the same time at this modern loading rack. The picture graphically illustrates the efficiency and speed with which the country is supplied with petroleum products.

The first attempt at pipe lines in America met with the fate of the Russian experiment. Even though the pipes here were of iron, they leaked at the joints. The adoption of carefully welded joints solved this problem and now there are more than 25,000 miles of oil pipe lines in the United States. In Mexico, at certain points where the water is too shallow for the oil steamers to come to the shore, the pipes extend for a mile and a half out at sea, where the ships are loaded. The larger part of the crude petroleum produced in the United States goes to the refinery through pipe lines. The lack of pipe lines to wells and the transportation of the products of the refinery present another phase of the situation, the part of the tank car.

The idea of the tank car was made to serve during the first decade of the industry with wooden tanks on trucks. The first modern type of tank car was constructed in 1871, it being a horizontal cylinder tank of boiler plate.

No single invention has played a greater part in the oil industry. The tank car provides transportation for the oil from the very mouths of the wells when pipe lines have not been built. For the distribution of petroleum products it can not be replaced. The products must be distributed as far and wide as men live and work. The oil steamers that ply between the ports of the world embody certain of its cardinal principles. The motor and horse-drawn tanks that travel the country roads with gasoline and kerosene and other oils are miniature tank cars.

The distinction of Standard railroad tank cars is in the strength and refinements enabling them to carry any and



all petroleum products with safety and economy. At big plants oil racks are provided to load whole trains of tank cars at one time. Only the speed of railroad engines limits the dispatch with which tank cars perform their mission.

The final thought on petroleum is its occurrence. While the oil is of common occurrence in small traces, its discovery in commercial quantities is restricted and fields of great importance are few.

There has been a world-wide search for new fields, but the supply comes largely from three countries—the United States, Russia and Mexico. For ten years prior to 1870, the one great oil production section of the world was Pennsylvania. New fields have been discovered and developed in the United States until Pennsylvania now greatly is outranked by several States. The fields in Russia and Mexico were developed to supply a rapidly increasing world demand.

Russia came into prominence as a petroleum producer with the completion of the first flowing well in the Baku district, around the Caspian Sea. New fields have been developed in that country in the Caucasus Mountains and along the northeast coast of the Black Sea. There is great promise of future wealth in the Russian fields. While up until recent months Russia stood second to the United States as a producing country, it now is claimed that Mexico has outstripped her.

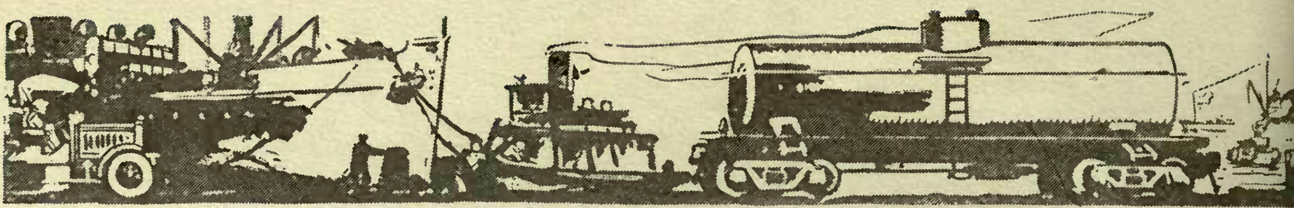
The great Mexican fields are around the eastern coast, near Tampico. These are controlled by American and

British companies, it being estimated that Americans have invested $300,000,000 in Mexican oil. Revolutions and unstable governments have had a retarding effect on the industries in both Mexico and Russia.

In 1917 the United States produced 66.98 per cent of the world's supply, or 335,315,601 barrels. Its proportion is considerably greater today, though later figures on the foreign countries are not available at this time. The following table gives the number of barrels produced by the foreign countries during 1917:

Russia	69,000,000
Mexico	55,292,770
Dutch East Indies	12,928,955
India	8,500,000
Galicia	5,965,447
Japan and Formosa	2,898,654
Rumania	2,681,870
Peru	2,533,417
Trinidad	1,599,455
Argentine	1,144,737
Egypt	1,008,750
Germany	995,764
Canada	205,332
Italy	50,334
Other countries	530,000
Total of the world	500,651,086

In many of these countries the fields have not been developed to anything like their capacity, and oil men in America,



appreciating the increasing demands for petroleum products and the drain on the supply in this country, point to these foreign countries as opportunities for the future, especially to Mexico, South America, Russia and Africa.

It is interesting to note the number of barrels produced in the United States by States during 1918, as follows:

California	97,531,997
Colorado	243,286
Illinois	13,355,974
Indiana	877,558
Kansas	45,451,017
Kentucky	4,367,968
Louisiana	2,738,201
Montana	69,323
New York	808,843
Ohio	7,285,005
Oklahoma	103,347,070
Pennsylvania	7,407,812
Tennessee	8,374
Texas	38,750,031
West Virginia	7,866,628
Wyoming	12,596,287

Others not enumerated produced a total of 7,943 barrels, bringing the total for the whole United States up to 355,927,716. The producing areas are classified as the Appalachian fields, the Lima-Indiana field, Illinois field, Mid-Continent field, Gulf field, Rocky Mountain field and the California field.

The Mid-Continent field has since the beginning of 1919 exceeded all others in production. During the month of June, 18,134,000 barrels were secured there against a total production for the United States of 31,239,000 barrels. Central and Northern Texas alone during this period produced 5,630,000 barrels, or an increase of more than 400 per cent over June, 1918. The result has been that the eyes of the oil world have been turned more towards Texas than to any other place on the globe.

CHAPTER II

Casinghead Gasoline

The Effect of the Automobile on the Production of Gasoline

WE have included references to gasoline, as one of the liquids with which tank cars serve the nation, among the several products of petroleum. It is exclusively a petroleum product, but it is derived from both liquid petroleum and petroleum gas. The product of the latter is distinguished as casinghead gasoline. Its extraction is sufficiently distinct in method, and its history and development throw such light on the supply and demand of gasoline, as to make it a distinct subject.

The average automobile owner probably assumes that all gasoline comes from the crude liquid petroleum. If his assumption were true, there would be fewer automobile owners, for the price of gasoline would become prohibitive. The production of casinghead gasoline in 1917 was 250,000,000 gallons and there was a big increase in the amount in 1918. The annual value of the product almost equals that of the natural gas industry, and it is growing rapidly as new petroleum fields are being developed.

The source of the petroleum gas is the oil well. When gas but no oil is secured, it is called natural gas. When both

oil and gas flow, the gas is designated as casinghead gas. Casinghead gasoline is derived from both sorts of wells, the name being taken from the casinghead at the top of the casing of the well.

Gas flows from all oil wells, but in varying quantities, from a few cubic feet to several hundred thousand a day.

Neither is its quality constant. Sometimes the natural gas, known as "lean gas," carries as low a percentage of gasoline as one-tenth of a gallon per thousand cubic feet of gas, while the casinghead gas may be as rich as several gallons per thousand cubic feet. An aid is given the industry by the fact that both casinghead and natural gas still may be used for light and heat after the gasoline has been extracted. Some gas men maintain that the extraction of the gasoline makes the gas a better commercial product.

The making of casinghead gasoline as an industry was developed as late as 1903. It is not strange that so important a raw material was allowed to go to waste for so long when it is remembered that gasoline for years was a relatively valueless by-product of the petroleum industry. The internal combustion motor called gasoline into use, and the tremendous increase in automobiles, with the subsequent increased demand for gasoline, caused the casinghead gasoline industry to grow to importance.

It simply was a result of the law of supply and demand. In the last eight years the production of gasoline has increased more rapidly than that of petroleum itself. In 1910 there were 50,000,000 barrels of petroleum produced and 10,000,000 barrels of gasoline. In 1917 the output was

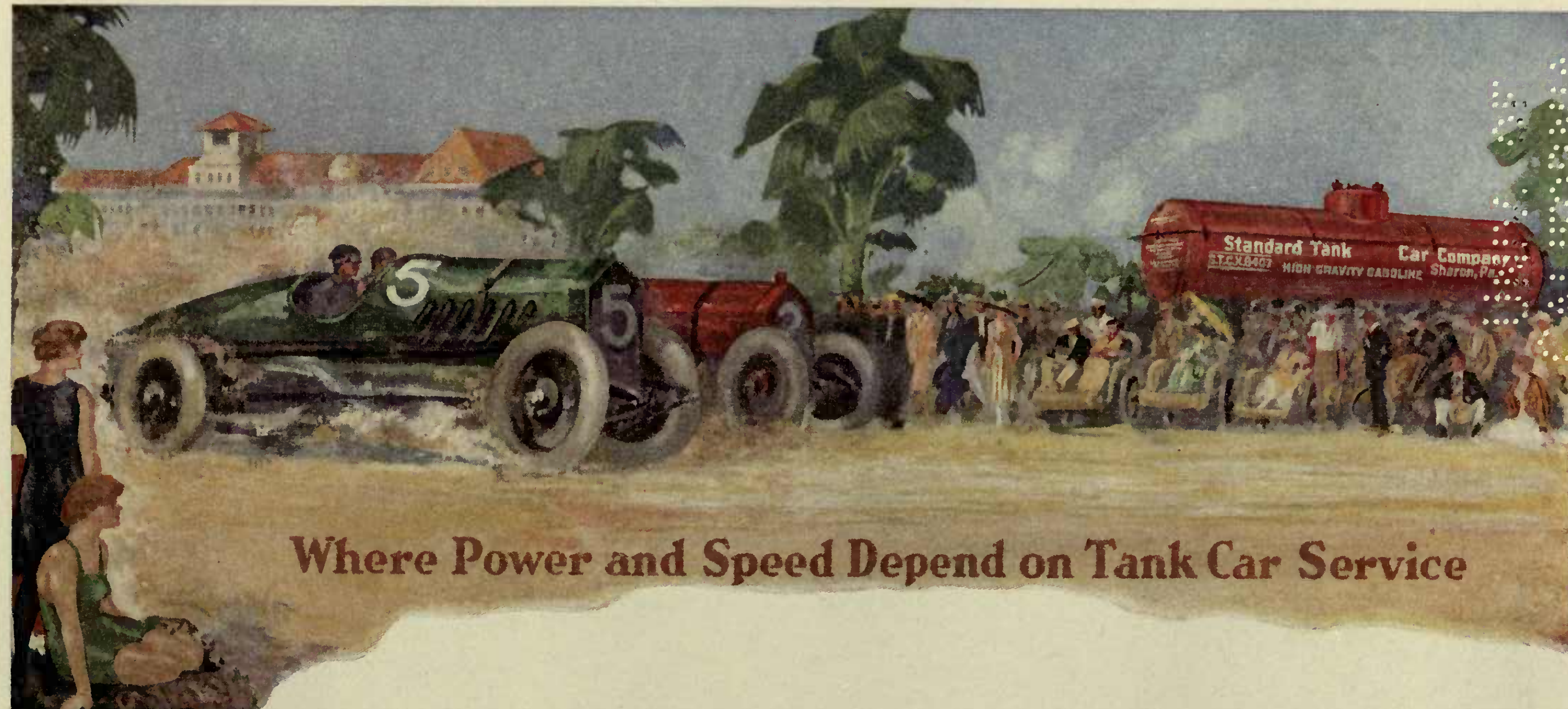
280,000,000 barrels of petroleum and 65,000,000 of gasoline. Thus it is evident that the old proportion of one barrel of gasoline to five of petroleum has been reduced.

There are two methods employed in the preparation of casinghead gasoline, the compression process and the absorption process. There are no restrictions on the size of the plants and they are of many types. Plants of any proportions, however, are located within a radius of a number of wells, with which they have gas pipe connections. The gas is purchased by the cubic foot, the price usually being regulated by the price of gasoline. Whether a plant uses the compression or the absorption system, it always is equipped with a vacuum pump; for it is a simple law of physics that a reduction of air pressure in the wells will cause a greater flow of gas, and of oil too.

The compression system consists in passing the gas, under pressure of from one hundred to three hundred pounds, through a series of coils, on which cold water is constantly dripping. The gasoline condenses and the gas passes on out, to be consumed for heating and lighting purposes. The gasoline is collected in tanks and then is blended with less volatile naphtha. The blending lowers its specific gravity and makes it satisfactory for use in motors.

In final form it is a high grade gasoline, the process enabling the oil man to sell naphtha for use in motors, which he could not do with this liquid in a free state. Casinghead gasoline is the most satisfactory grade for airplane motors.

The higher the pressure in this system the greater the proportion of gasoline condensed. But the gasoline obtained



WHERE POWER AND SPEED DEPEND ON TANK CAR SERVICE

Computations based on estimates of the National Automobile Chamber of Commerce show that nearly 6,000,000 automobiles in the United States roll up a total of 60,000,000 miles a day. To give equivalent service on the railroads would require the addition of 18,000 locomotives and 75,000 passenger cars.

AMERICAN PLANES IN BATTLE FORMATION

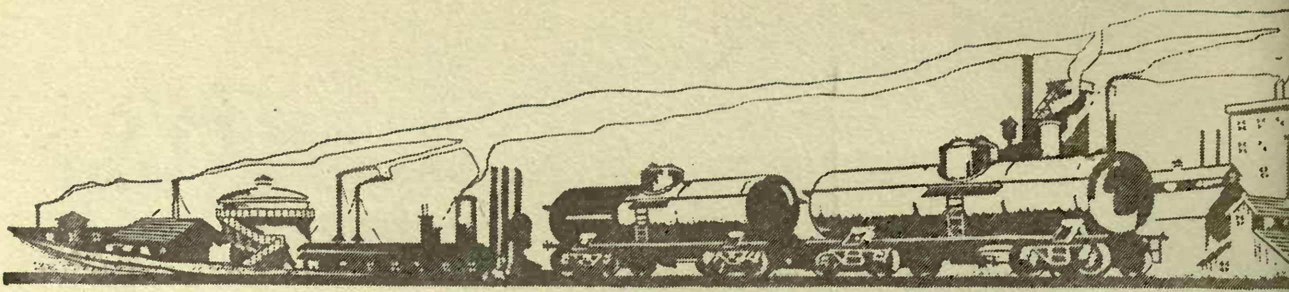
This picture, taken at Rockwell Field, Cal., shows the way our aeroplanes met the enemy in France. A great aid to the Allies in winning air supremacy was an adequate supply of high-grade gasoline, such as casinghead gasoline for aeroplane motors.

from the extra pressure immediately evaporates on contact with the air, and, therefore, it is unwise commercially to try to obtain too great a proportion.

In the absorption method, the gas is brought into contact with petroleum oils heavier than gasoline. They use horizontal cylinders, by which the gas is sprayed into the oil; or vertical cylinders, by which the gas is sent in at the bottom and the oil sprayed in from the top. The oil absorbs the gasoline, and then it is distilled on the same plan as petroleum. This method is used almost exclusively in treating natural gas. The gasoline maker is able to use the oil over and over again.

The first casinghead gasoline was obtained by placing coils in gas pipe lines. It had been observed that gasoline condensed in gas pipes, where they ran through low and cool places. The amount now secured from this source is not insignificant. It is estimated that the value of casinghead gasoline in 1918 amounted to approximately $60,000,000.

Any gasoline must be kept under pressure and at a relatively low temperature, for heat increases the pressure tremendously. Standard Tank Cars which carry it are built of extra heavy steel, able to withstand a pressure of at least 125 pounds, in order to conform with the law. They are covered with a two-inch magnesia composition and a one-eighth-inch steel covering over that. Safety valves, set at twenty-five pounds per square inch, also are provided. Another feature which may be provided is a special dome preventing inexperienced persons from opening the car.



CHAPTER III

Coal-Tar

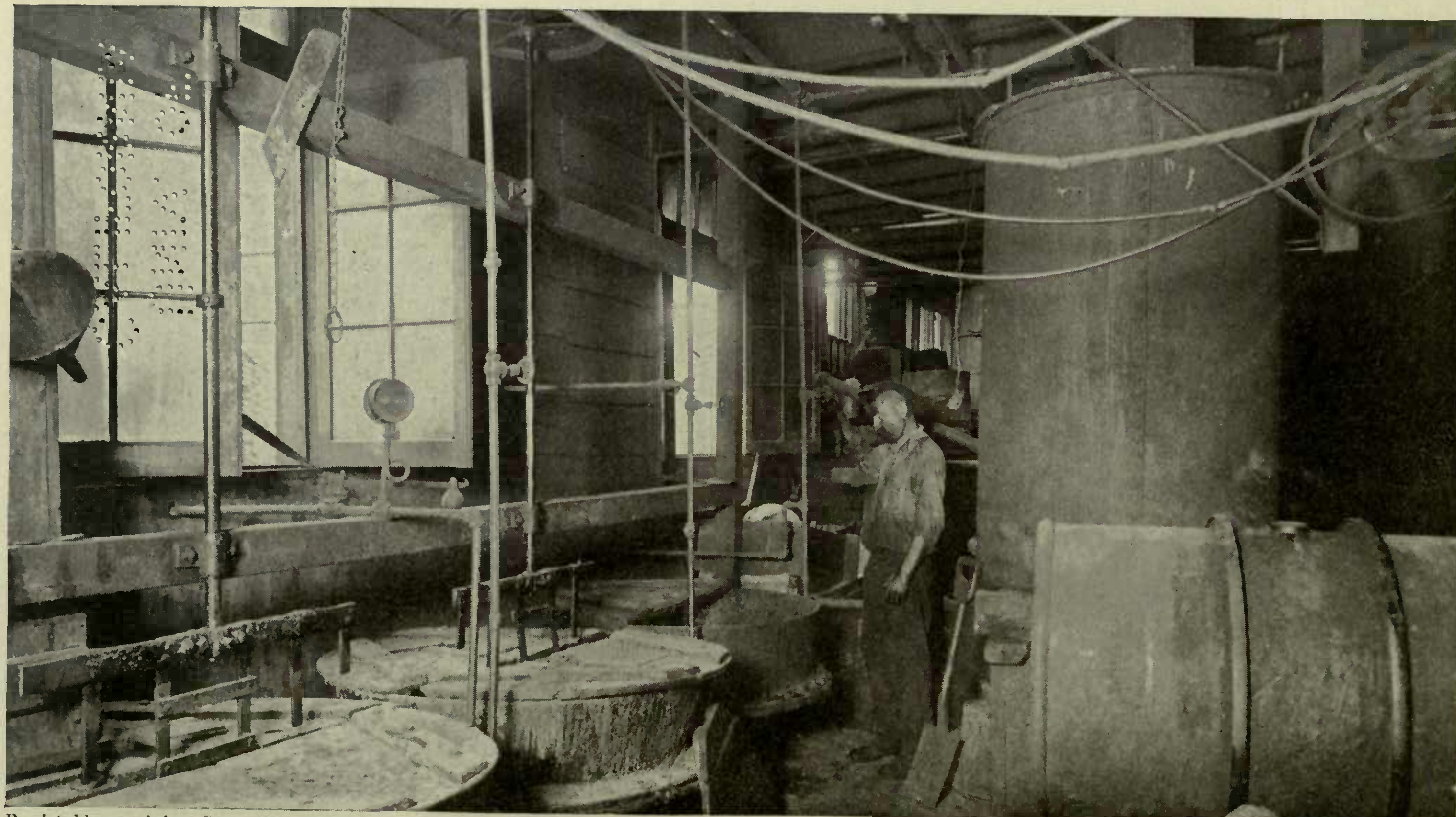
Development of the Manufacture of Dyestuffs, Refined Drugs and Chemicals

COAL-TAR is a charmed word in industry. It caught popular interest through the fact that from this cheap and plentiful material ways were found to manufacture refined products that have marked a new era in many industries. Coal-tar dyestuffs alone affect every civilized being.

While America for a long time has manufactured its own considerable supply of heavy oils and pitch from coal-tar, it took the Great War to awaken interest in the manufacture of the dyestuffs, refined drugs and chemicals for use in explosives and for various other purposes. The raw materials were here but capital was timid in investing in the plants and machinery necessary to compete with Germany in these products. Germany had developed a world trade in chemical dyes and coal-tar drugs and chemicals. The Teutons virtually had a monopoly until the blockade during the war compelled our manufacturers to overcome the difficulties in their way. The coal-tar products industries in America now are rapidly attaining a position of independence.

PREPARING COAL-TAR DYES

Coal-tar is a product of bituminous coal. The dyes are prepared from the raw material and from a number of intermediate products. The illustration above shows the baking of an intermediate product.



COOKING FOR BLACK AND RED TAR PRODUCTS

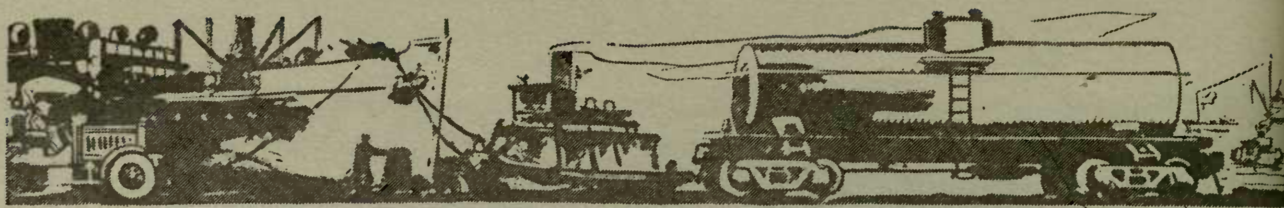
Coal-tar dyes virtually have supplanted all others in industry. American manufacturers now produce 175 coal-tar colors as a result of the war, wresting from Germany a practical monopoly in chemical dyes.

Coal-tar products really are coal products. The discovery of these valuable components of coal has had a great effect in pointing the way to secure numerous petroleum products.

Coal-tar is a by-product in the manufacture of coke. Another source of its most valuable component, benzol, is to strip it from coal gas. Millions of tons of coal are used every year in the United States for coke and gas manufacture. Steel mills require great quantities of coke and every city resident knows of the needs for gas for heating and lighting. These industries make possible almost unlimited supplies of coal-tar and benzol. Only the demands of the market limit them. The maximum supplies are not produced because frequently it is simpler and cheaper to use the old beehive coke ovens instead of the modern by-product ovens, and because stripping benzol from gas reduces the illuminating power of gas. Increased efficiency undoubtedly soon will stop this wastage, for the usefulness of coal-tar products grow as each year passes.

Coal-tar, a black, viscous and sometimes semisolid fluid, is worth its weight in coal as fuel. It is unpopular in this use because of an evil smelling smoke it produces. Where appearance does not count, it is employed as a cheap paint to preserve wood and metal.

The materials for the numerous valuable coal-tar products are secured through the fractional distillation of benzol and coal-tar. As benzol is one of the distillates of coal-tar, it is not necessary to treat it as a separate subject. The distillates of coal-tar divide into four natural classes—light oils, middle



oils, heavy oils and pitch. The commercial products of these distinct classes and their uses are as follows:

From light oils—benzol and solvent naphtha, for solvents, paint thinners, motor fuel and gas enrichment; nitrotoluenes, diphenylamine and other ingredients of explosives; aniline dyes; hydroquinone and other photographic developers; drugs and medicines.

From middle oils—disinfectants; picric acid, picrates and other nitrocompounds for explosives; naphthol dyes and colors; artificial indigo and refined carbolic acid.

From middle and heavy oils—creosote, for preserving wood products, such as railroad ties, paving blocks and piling and structural timbers; lamp black, for electric carbons, printing inks, shoe-blacking and patent leather.

From heavy oils—road oils; alizarin dyes.

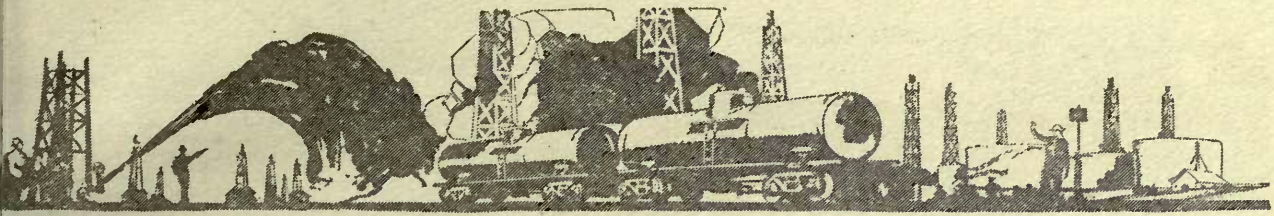
From heavy oils and pitch—roofing tars; paving tars.

From pitch—protective paint and for briquetting fuel.

It is obvious that many coal-tar products have a commercial usefulness in a crude state. The more refined products, however, require complicated chemical processes in their preparation. Germany's aggressiveness in this particular gave that country dominance in the field and for years caused the United States to import its principal supplies.

The use of coal-tar products in explosives is a study within itself. These products—principally benzol, toluol and naphtholene—are indispensable to many modern explosives.

A growing demand for certain of the products is in the moving picture industry. This industry employs the pho-



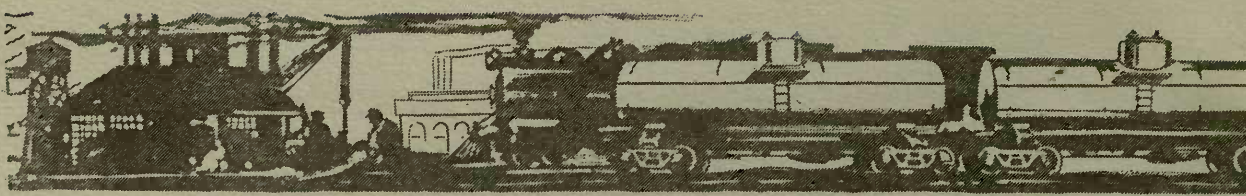
tographic developers and a form of celluloid, made by condensing carbolic acid with formaldehyde.

Before the celluloid film was applied, moving pictures were little more than a theory. Thomas A. Edison had conceived the theory of the motion picture machine but no film could be found that would serve it. Glass, it was obvious, would not do and paper and various other materials were tried without success. It was due to the tireless research of Mr. Eastman, of the Eastman Kodak Company, that, some thirty years ago, celluloid was introduced in the roll film. Mr. Eastman's success not only revolutionized photography but gave Mr. Edison the missing link for which he was searching. Mr. Edison then gave us moving pictures.

Among the many drugs secured from coal-tar products are phenacetin, saccharin and aspirin. It may easily be imagined how difficult it would be to transport coal-tar in quantities without tank cars. The tanks must have at least six lines of steam coils that the tar may be heated for unloading. After coal-tar has been shipped in a tank car, it is impractical to use the car for refined oils, because it is almost impossible to clean all the coal-tar out.

Commercially pure benzol freezes easily, and, therefore, if shipped in a pure state, the tank car should be coiled. At any rate the tanks should be thoroughly clean and equipped with sealing devices. A precaution against evaporation is to cover the interior with a white paint.

Other coal-tar products handled in tank cars are naphtha, toluol, carbolic acid, creosote and the heavy oils.



CHAPTER IV

Turpentine and Rosin

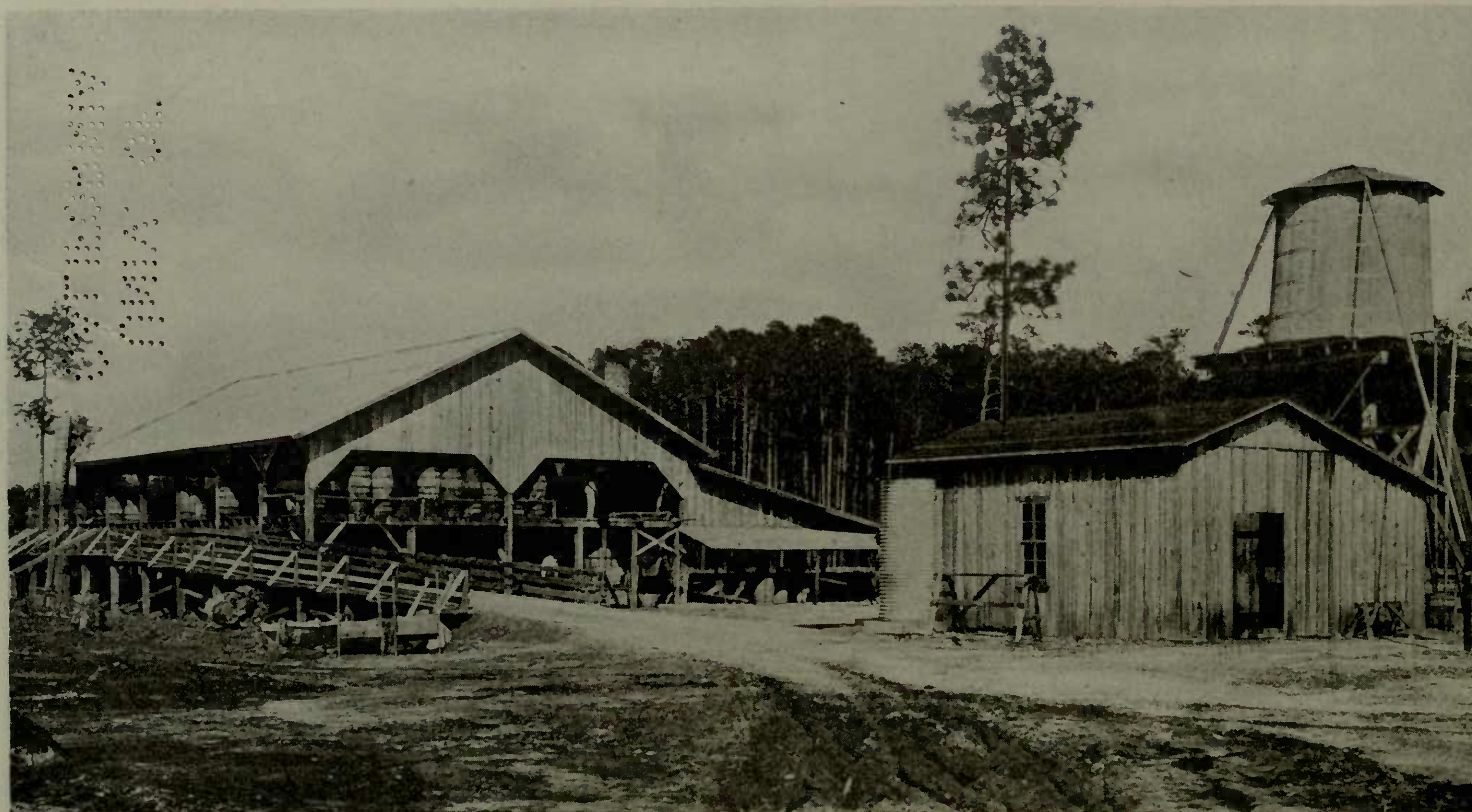
Their Production as the First American Industry; How the Pine Forests are Tapped for these Products and their Wide Usage

THERE is all the charm of Mother Nature's household in the naval stores industry. Naval stores have the dignity of being America's first export, for it is believed that the first products sent back to England by the struggling Jamestown colony were tar and pitch for calking the ships and smearing the rigging of the King's Navy. The sailors, therefore, usually had their hands covered with tar, and with it they used it to slick their tightly plaited hair, probably gaining from its odor the nickname of "Jack Tar."

The fine history of naval stores, however, is a record rather than an indication of the commercial and industrial importance of the products today. Included in them are turpentine, rosin, tar and pitch. The latter two still are in demand for ships. Manufacturers of cordage require a great supply of pitch as a preservative for ropes and in the preparation of oakum for calking ships, but the use of the products as a

THE SOURCE OF NAVAL STORES

A pine forest being farmed for resin, from which turpentine and rosin are distilled. Note the cups on the trees to catch the resin, or sap.



A LOUISIANA TURPENTINE STILL

The pine tree sap is heated in great iron stills. The turpentine passes over as a vapor and is liquified in a coiled pipe. The residue, cleaned of trash, is commercial rosin.

whole for naval stores is a minor one. Modern chemistry has developed so many purposes for turpentine and rosin that they have become prime essentials in innumerable industries.

Turpentine and rosin are products of the distillation of the crude resin of the long leaf pines of the South. Tar is secured by the destructive distillation of pine wood, and pitch is then produced by boiling the tar. These raw materials are still obtained in much the same way as was done by the early colonists. The distilleries are even more picturesque today, since darkies do the work, deep down in the regions of the yellow pine forests. After tar and pitch, turpentine was discovered, and rosin was a waste by-product which was dumped into streams or buried in pits. In later years, when the value of rosin was discovered, these pits became known as "rosin mines," and small fortunes were made by locating them and marketing their contents.

The first method of gathering the crude resin was to cut a cuplike cavity in the trunk of the tree near its base and then scarify the trunk for some distance above the cavity. From early spring until fall, the resin, or sap of the tree, exuded and was collected in the cup. This was known as the "box system" and it was wasteful, both in handling the resin and in injuring the trees.

The present method substitutes a metal or pottery cup beneath the scarified surface of the trees, and economizes both wastage and the life of the tree. Trees now are "farmed" three or four seasons.

Skillful hands collect the resin, and it is taken in barrels to a nearby distillery. The still is composed of a big copper retort, of from twenty to thirty barrels capacity, with a goose-neck cap and worm similar to a whiskey still. The worm passes through a tank filled with cold water, and empties into a receptacle for the distilled spirit. To the gum in the retort is added water. When fire in the furnace underneath has produced a temperature of about 300 degrees F., the process of distillation begins.

Turpentine is the distilled product, and, being lighter, it separates from the water that passed over with it by rising to the top. The residue left in the retort is rosin, and it is drained out through a tail-gate and strained into a marketable product.

When the sap oozes from the trees it is a colorless liquid, but exposure to the air gives it an opaque cast. Pure turpentine is a clear liquid, its market grade being determined by its degree of clearness. Rosin, too, is similarly graded, its color ranging from black to pale lemon yellow.

The greater part of both products is handled in barrels, but on large scale production it is stored in steel tanks, and then transferred to tank cars, to be shipped to the markets of the world.

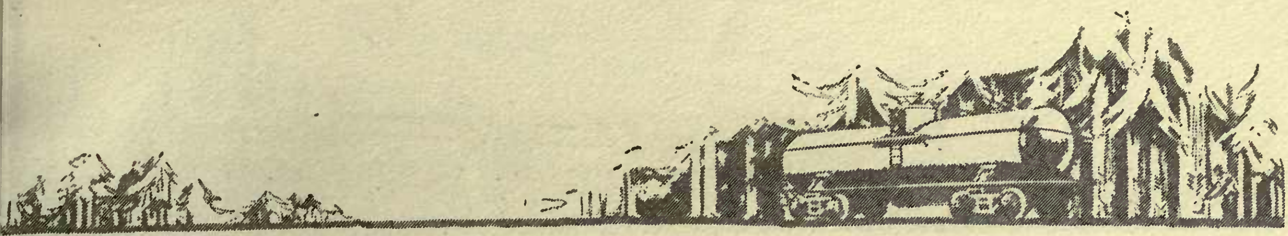
As a volatile thinner for paints, and to accelerate the oxidation of drying oils, turpentine never has been equalled by any substitute. In the manufacture of paint in America there is an investment of something like a billion dollars, and work that gives employment to approximately 100,000 men.

MODERNIZING THE OLDEST AMERICAN INDUSTRY

Three hundred years ago the pine forests of Virginia were tapped to supply the British navy with tar and pitch. Today this earliest American industry supplies the vast quantities of turpentine and rosin required as ingredients in paints, soap, printing inks and in many other useful materials—tank cars providing the transportation.

CALKING A WOODEN SHIP

The use of naval stores in shipping today is a minor one, but tar and pitch still are employed in the manufacture of cordage and in the preparation of oakum for calking the hulls of wooden ships.

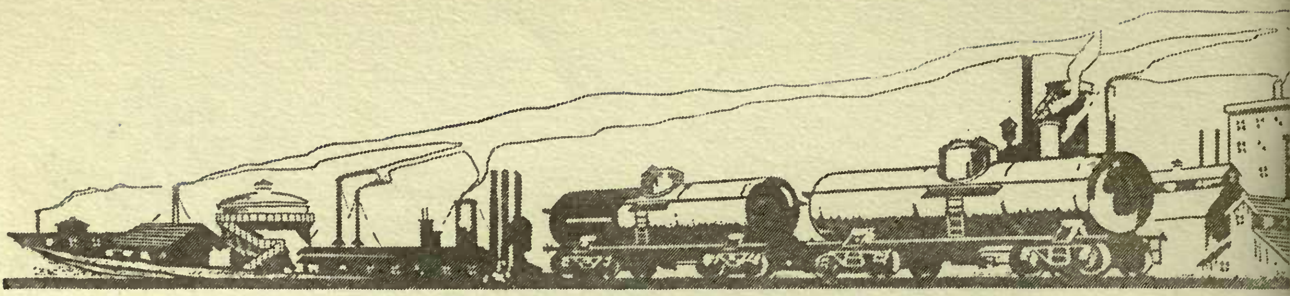


Other industries in which it plays a necessary part are as follows:

The manufacture of printing inks, and in lithography; the manufacture of patent leathers; as a solvent for waxes in shoe and leather polishes, and in floor varnishes and furniture polishes; as a solvent for waterproofing, for rubber and similar substances; in refining petroleum illuminating oils; as an ingredient in belting greases; as an insecticide; in laundry glosses, washing preparations, stove polishes and sealing wax; a raw material in synthetic camphor and, indirectly, celluloid, explosives, fireworks and many medicines; in the manufacture of disinfectants, liniments, poultices, medicated soaps, ointments and internal remedies; in producing terpineol, and last, but not least, as an indispensable article in the family medicine chest.

The greatest use of rosin is in the manufacture of soap and in surfacing writing and printing paper. Other uses are in the manufacture of varnishes and paint driers, in waterproofing compounds, in roofing materials, in leather dressings and shoe polishes, in sealing wax and shoemakers' wax, in the making of linoleum and oil cloth, in dry batteries and electrical insulations, as a lubricant for high speed machinery, in steel hardening, floor waxes and polishes, in disinfectant sweeping materials, in cements, in printing inks, in rubber substitutes, axle grease, to dust molds in foundries, in many pharmaceutical preparations, and for innumerable minor purposes.

Turpentine requires a clean tank car. Some shippers paint the inside of the cars with white enamel to show off the qual-



ity of the spirits, but most of them merely shellac the interior to prevent the metal from discoloring the turpentine.

For rosin a standard car without coils is used.

For pitch a coiled car must be used in order to melt it with steam before unloading it. After once having been used for pitch, the cars are unfit for anything else but crude and fuel oils, as they are very difficult to clean.

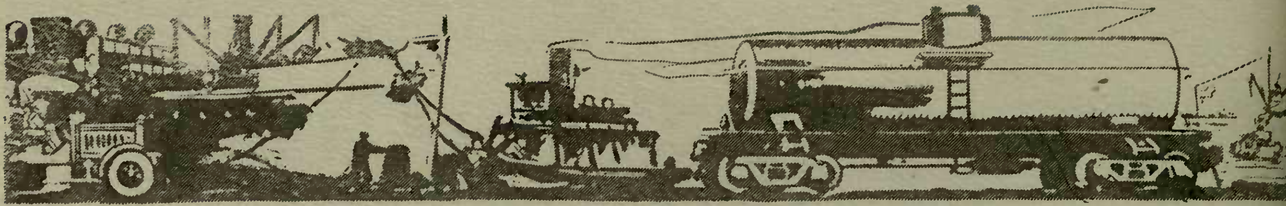
CHAPTER V

Alcohol

Ethyl and Methyl

TWO kinds of alcohol play a big part in industry today—ethyl alcohol, or the spirit of fermented liquors, and methyl alcohol, or wood alcohol. While the former is much more useful, efforts of governments to circumscribe its use for beverages for a long time greatly retarded its commercial development and caused methyl alcohol frequently to be substituted for it. The greatest restriction on its production was a heavy tax; but this tax on denatured alcohol was removed on January 1, 1907, by an act of the United States Congress, and now even undenatured alcohol pays no excise duty, when it is to be used, under license, in medicine and drugs and for the manufacture of explosives.

Denatured ethyl alcohol generally is known as industrial alcohol. It is a light colorless liquid, secured from vegetable sources. The process of manufacture is its conversion, through fermentation and distillation, from starchy and saccharin matter, the product being separated, concentrated and rectified.



There is a wide range of materials from which alcohol may be obtained; namely, corn, rye, barley, rice, sugar beets, both white and sweet potatoes, and sugar-cane molasses. The main sources for production on a commercial scale, however, are corn and sugar-cane molasses. Alcohol may be made from sugar beets, but the beet molasses is more suitable as an ingredient of cattle feed.

The first step in its manufacture is to clean the material of all dirt, stone, trash, et cetera. Then a mash is made, and after the first stages of fermentation have been reached, cultured yeast cells are put in. The chemical action is that the starch and saccharin matter are turned to sugar, and the yeast attacks the sugar, splitting it into alcohol and carbon dioxide.

The fermentation virtually is the same as that which takes place in the making of wine, except that cultured yeast cells are added, while the must of grapes supply their own, and the making of alcohol is not nearly so delicate a matter as the fermenting of a wine that must have a particular taste and quality.

Long as fermentation has been employed by man, it is only in recent years that its chemistry has been understood.

Pasteur propounded the theory that "it was life without air." He considered that the action of the yeast on the sugar was caused by its thirst for oxygen. The theory now accepted is that there is a substance in the yeast known as enzym,

which acts upon sugar like digestive juices. This has been proved by expressing the juice from the yeast cells and then applying it to sugar, with the result of fermentation.

But the analogy to wine ends with the fermentation, for the alcohol is obtained from the mash by distillation. It is purified and rectified by a repetition of the process of distillation. Its volatility being of a different degree to that of water, fusil oil and the other elements with which it is mixed, it can easily be separated by distillation to a state of purity of from ninety to ninety-five per cent. If absolute alcohol is required, it can be secured through the use of quicklime, metallic sodium or other chemicals, but for general uses distillation carries it far enough.

Its denaturing is accomplished by the addition of wood alcohol, benzol or such other liquid as will destroy its character as a beverage and make it unfit for use as a medicine. The denaturing liquids are usually poisonous and very unpleasant to the taste. Government regulations specify their proportions. The alcohol can again be purified but it is far easier to make raw whiskey than to go through the process.

Valuable as it is in industry, ethyl alcohol has many properties that as yet are but little utilized. Except for cheaper petroleum and coal products, it would serve as an illuminating oil, as power for motors, and for heating and cooking. Though it is not now a competitor of gasoline, some day it may be.

Alcohol is required in quantities in the manufacture of smokeless powders. Mercuric fulminate, one of the most

useful high explosives known, is formed by the action of mercurous nitrate on alcohol. This form of explosive is employed principally in cap composition, fuses and detonators.

Alcohol's greatest use in industry and in the arts is due to its power as a solvent. It readily dissolves most organic compounds, resins, fatty acids, many metallic salts and hydrocarbons. This property gives it high value in medicine, particularly since in composition of ten per cent and more it is an antiseptic. Many liniments are largely alcoholic. If applied to the skin, alcohol evaporates rapidly, having a cooling effect that reduces fever, expands the blood vessels and produces a mild counter-irritant. It also has an effect on the secretion of the juices in the stomach which tends to relieve pain.

Alcohol, of course, is the intoxicating quantity in beers, wines and liquors.

It is important in the manufacture of varnishes and lacquers. Shellac gum with alcohol makes spirit varnish. Other uses are in making of sulphuric and acetic acid, ether, chloroform, photographic films, both dry plates and papers; aniline colors and dyes and flavoring extracts.

Human suffering has been greatly alleviated by the uses of ether and chloroform as anaesthetics. Ether also is employed in smokeless powder, to manufacture artificial silk and for refrigerating purposes.

The government has not discontinued its supervision of alcohol, and for its shipping very tight tank cars with sealing devices are required.

Wood Alcohol

Wood, or methyl, alcohol is secured through the destructive distillation of wood. It is called destructive distillation because the process destroys the wood, dividing it into its distillates and charcoal. The favorite woods for making this product are maple, birch and beech, and the distilleries are located where such woods are available.

The process is dry distillation. The wood, cut into uniform blocks, is packed into steel cars and rolled into big ovens. The distilled spirit passes out through the neck of a huge retort and charcoal is left in the cars. To prevent the charcoal from bursting into flames when it is removed in a high state of heat, it is placed in compartments to which air has no access.

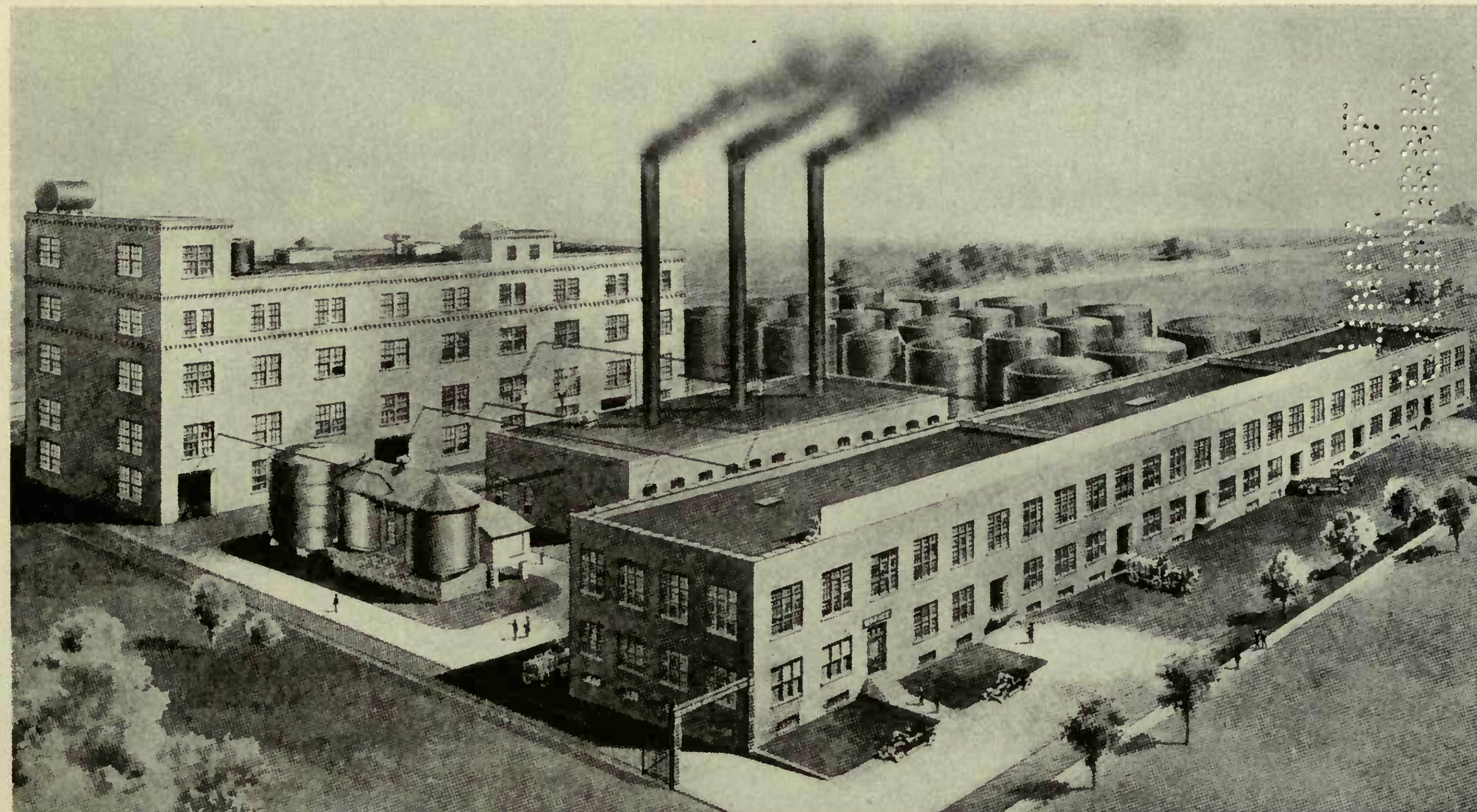
The product of the first distillation contains many elements and it must be distilled again and again to obtain anything like pure methyl alcohol. In the second distillation, wood naphtha and crude acetic acid come off, leaving tar, creosote and heavy fuel oils. The tar and heavy fuel oils are sufficient to furnish heat for the operation of the distillery. They are burned by a jet of steam which sprays the heavy liquid over the furnace, just as the heavy oils from petroleum are used for fuel. The distillate is now neutralized with lime and again distilled. This time wood naphtha comes off and leaves acetate of lime. From this

latter product chloroform, acetic acid and acetone are made, which have a use in the manufacture of explosives and in various other industries.

Heavy and tarry bodies are further removed from the wood naphtha by distillation, and then it is sent to a refinery where it is purified with lime and other alkalis, the final product being wood alcohol.

In modern methods a cord of wood will yield some twelve gallons of wood alcohol.

Highly refined methyl alcohol is hard to distinguish from ethyl alcohol, except that it is poisonous and very distasteful. Abroad it is the favorite denaturing agent for ethyl alcohol. For many purposes it is a good substitute for ethyl alcohol. Its consumption also is embraced in the manufacture of formaldehyde, in aniline dyes, and in the preparation of different varnishes.



WOOD ALCOHOL MANUFACTURING PLANT

Wood alcohol is manufactured by the destructive distillation of certain woods. It is similar in appearance to ethyl alcohol and frequently is used industrially as a substitute for it.

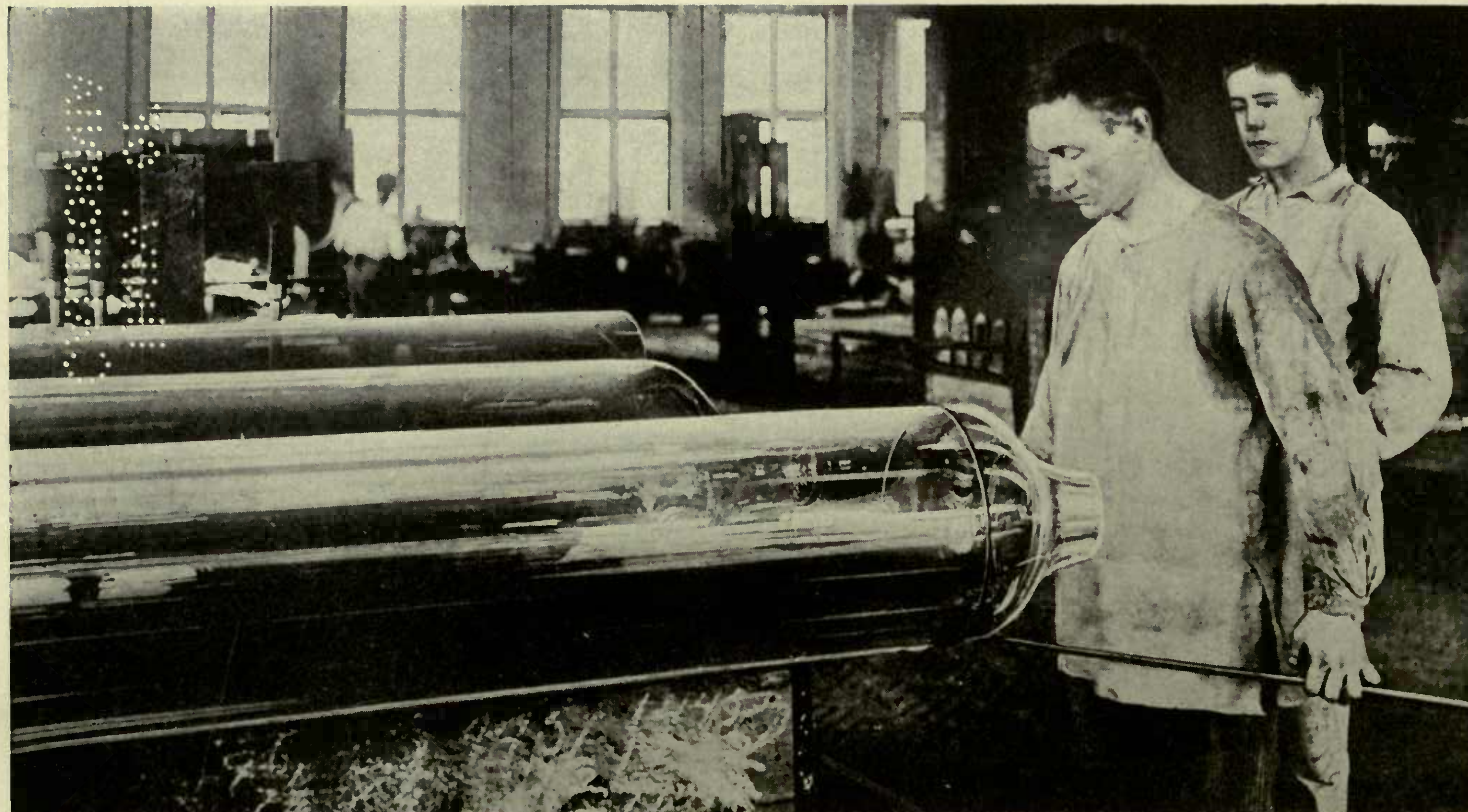


Photo by International Film Service Co., Inc.

PREPARING PLATE GLASS

White sand, potash, soda, lime and other materials are used in the manufacture, and "Standard Tank Car Journeys" tells how commodities transported in tank cars enter into the making of soda and potash. The large cylinders in the picture are cut and rolled flat for plate glass.

CHAPTER VI

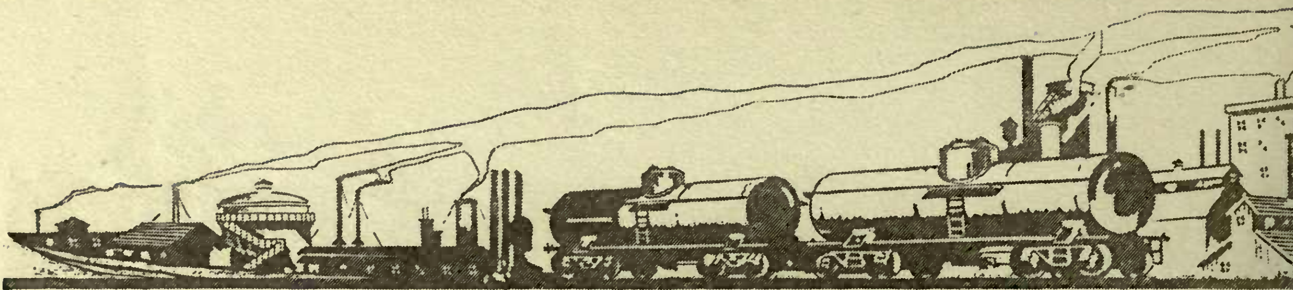
Sulphuric Acid

The Making and Use of this Most Important of Commercial Chemicals

BECAUSE of the quantities in which it is produced and the multifarious uses to which it is put, sulphuric acid is the most important of all commercial chemicals. In fact, it has been said that the degree of a nation's industrial progress can be measured by its consumption of sulphuric acid.

The essentials in the production of the acid are the burning of sulphur, or sulphur dioxide, and combining the sulphur dioxide thus formed with more oxygen and water. In industry this is accomplished by a number of processes; sometimes for the direct production of sulphuric acid but often as a by-product, as in the smelting of sulphur ores.

Sulphur is found in considerable quantities in the free state as brimstone, especially in Louisiana. Brimstone is easily burned; once started it will continue without any extraneous help. It gives off fumes in the form of sulphur dioxide. These fumes are collected in a dome over the kiln and conducted by a flue into chambers for further treatment.



To be converted into sulphuric acid, the sulphur dioxide must have added two parts of oxygen and two parts of hydrogen. Water will supply the hydrogen and one part of the oxygen. To give the needed part of oxygen, an oxide of nitrogen or some other oxygen carrier is introduced. One of the principal materials used is vapor of nitric acid.

The reactions that follow are very complicated, though it is well understood how they must be conducted. An important feature is that the chambers must be constructed of sheet lead, for the acid would attack and destroy almost any other material, and they must be of large proportions. Several chambers usually are connected, with the fumes to be treated sent in at one end and certain waste gases allowed to escape at the other. The water is introduced as steam.

The liquid acid that forms is good commercial sulphuric acid.

Means have been devised for conserving nitric acid and using it over again.

There are many variations in the machinery in which the fumes from the brimstone are converted into sulphuric acid. Many refinements have been invented, particular effort being directed to reducing the lead chambers. Nevertheless, the principles of all are virtually the same.

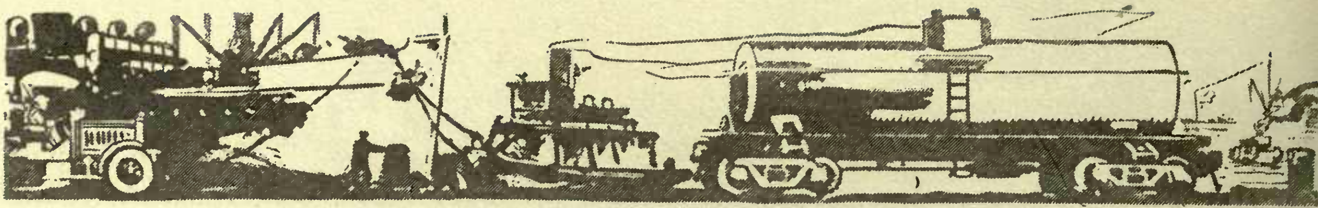
But a much larger percentage of sulphuric acid is produced from pyrites—copper, iron and zinc sulphides—than from free brimstone. As a by-product of smelting, sulphuric acid has become both necessary and very profitable.

A copper smelting plant was established at Ducktown, Tenn., some years ago to handle the product of pyrites mines there. No attention was given to the escaping sulphur fumes. Very soon there were strenuous protests from the farmers about. The fumes were killing all forests, crops and vegetation over a wide area.

The result of the situation was the passage of a State law requiring the fumes to be confined. The company conformed to the requirements, and now its production of sulphuric acid is a more important item than that of copper.

The first part of the smelting of pyrites ore consists in roasting it, that is, the oxidation of the sulphur and iron. Started with coke, it will continue through the power of its own heat. Sulphur dioxide passes off in fumes. In large plants a number of kilns are arranged in a row with an arch-shaped roof to conduct the fumes to a common flue. The kilns or burners are regularly recharged with ore so as to give a constant flow of the fumes. The fumes are collected and conducted into chambers for the treatment, which has been described, that converts it into sulphuric acid.

Pure sulphuric acid is a colorless, odorless liquid of an oily consistency. It is poisonous. It will attack most metals and to be transported must have tank cars of special construction. For a weak solution the tanks must be lead lined and for strong solutions there are special compositions for the lining. The acid is unloaded by compressed air through a pipe extending from the dome to the bottom of the tank.



Great quantities of sulphuric acid are used in purifying most kinds of oils. It clears them of all sorts of suspended and extraneous matter. Many vegetable oils, such as cotton seed oil, are made fit for food through purification by sulphuric acid. It takes away the odor and leaves the oils bright and clear. It is used to "sweeten" gasoline by perfecting the work of distillation.

It cleans or "pickles" iron in its preparation for tinning or galvanizing.

In the manufacture of artificial dyes and coloring matter from coal-tar products, it is employed as a dryer.

In fertilizers it serves as a solvent for phosphate.

It is most useful in the production of nitric acid, and with nitric acid in the forming of nitroglycerin and nitrocellulose, which are in great demand for explosives.

Through its quality of separating acids from their salts, we have its use in the manufacture of soda ash, soap, glass and bleaching powder.

The modern method of making fuming sulphuric acid is known as the contact process. Sulphur dioxide and air are passed over finely divided platinum at a suitable temperature, when they combine to form sulphur dioxide. The dioxide is dissolved in sulphuric acid, making the fuming acid.

CHAPTER VII

Muriatic Acid

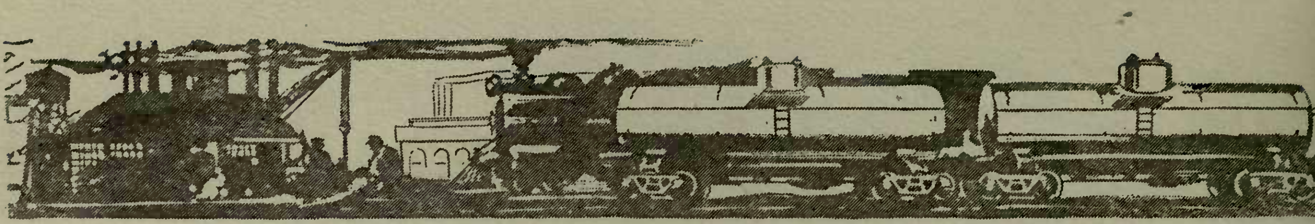
Another Primary Ingredient of Many Industries

THE production of muriatic acid, known in chemistry as hydrochloric acid, by the action of sulphuric acid on salt, was in progress before its commercial value was appreciated. The industry was the manufacture of salt cake or sodium sulphate, which largely was consumed in the making of glass. In this process salt or brine was heated with concentrated sulphuric acid. Sodium sulphate was formed and the freed muriatic acid gas escaped as fumes.

This was years before the Ducktown experience with sulphuric acid, and it was in England, but a similar situation developed. The fumes killed the vegetation and the English Government passed a law requiring that they be confined.

This law led to a large scale production of muriatic acid and its principal source as a commercial article still is a by-product in the production of salt cake, in the United States as well as in England.

The confined fumes are conducted to water and there absorbed, for water greedily assimilates it. The solution is the commercial form of muriatic acid.



Another process for its manufacture is known as Hargreave's process. This consists in passing a mixture of sulphuric dioxide, air and steam over highly heated salt. Sodium sulphate and muriatic acid again are formed and the acid is absorbed in water, as in the salt cake method.

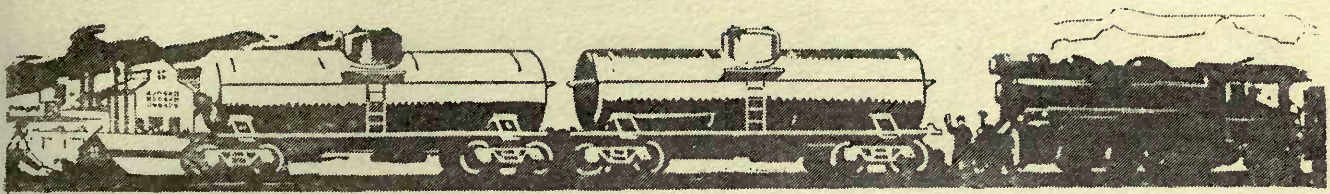
In neither case is the acid pure, but in industry it seldom is required in an absolutely pure state. The making of the pure acid can be achieved by distilling pure salt and sulphuric acid in platinum retorts.

Here are its principal uses in industry:

In the making of chlorine for the manufacture of bleaching powder; to produce chlorates; in color and dyeing industries; in purifying coke, iron ores and clay; in a similar use to sulphuric acid in "pickling" sheet iron—by removing dirt and rust and making a clean surface for the zinc to adhere to in galvanizing; in preparing clay for the potter, and in producing gold chloride for use in photography.

Muriatic acid eats the resin out of wood and penetrates steel. Standard Tank Cars in which it is shipped are constructed of wooden tanks inside steel shells, with a composition of tar and asphalt about two inches thick between the tanks and the shells. There are no outlets at the bottom of the tanks, the acid being syphoned out through the dome.

The acid, which is colorless, is comparatively cheap because there is a greater demand for sodium sulphate than for this by-product.



CHAPTER VIII

Nitric Acid

The Importance of Nitric Acid in the Manufacture of Explosives

NITRIC ACID, as is shown in the chapter on "Explosives," is the base of the various nitro compounds, and, therefore, is one of the most important of the materials for the manufacture of explosives.

Nitric acid is a combination of nitrogen and oxygen. Because of the abundance of these elements, it easily is obtainable in unlimited quantities. The very air we breathe is made up of nitrogen and oxygen, in other proportions. This fact led to long and diligent efforts to make nitric acid from air, and finally they have met with considerable success.

It was found that the passage of electric sparks through moist air produced nitric acid. The principle was applied industrially, by shooting currents of air through arcs of electric current of high voltage. This produces nitric oxide, which is enriched with more oxygen and converted into nitric acid by being conducted to a stream of water.

Other methods of obtaining nitric acid from air are the burning of phosphorus in a confined volume of air and by

evaporating liquid air. Free nitrogen first is secured and the nitric acid is prepared by a treatment with water.

Nitric acid also is produced by distillation processes. The materials used are sulphuric acid and compounds containing nitre, such as potassium nitrate, sodium nitrate and Chile saltpetre.

The oxidation of any nitrogenous matter in the presence of water produces nitric acid.

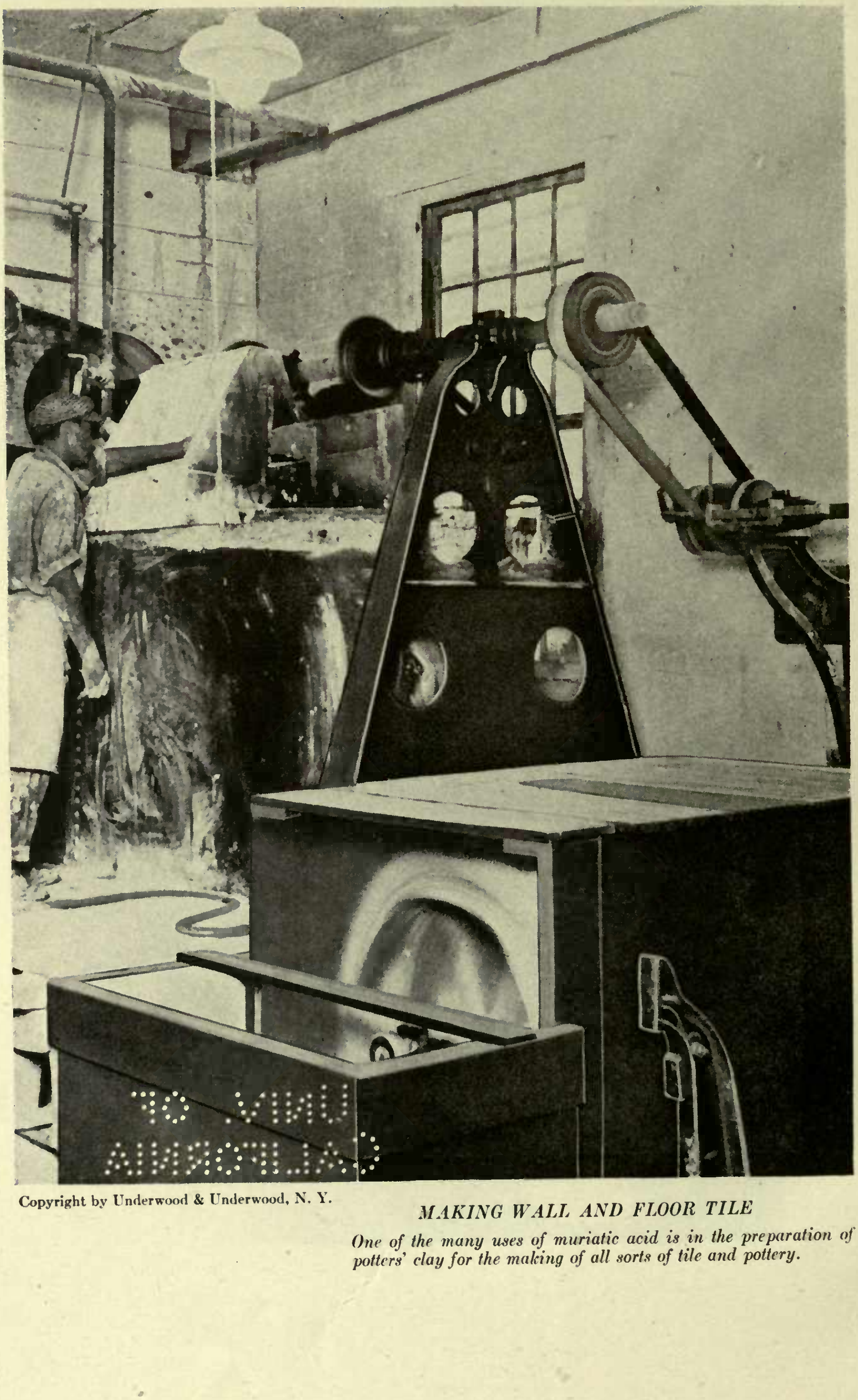
Under "Sulphuric Acid" it was shown that nitric acid is used in the manufacture of sulphuric acid from the fumes of roasting pyrites. Other uses are in the preparation of coal-tar dyes and to form various nitrates. The most important, of course, is in the manufacture of explosives.

Nitric acid is handled in a regular acid tank car in a solution of about seventy per cent, by weight, of water.

Courtesy E. I. DuPont de Nemours & Co.

EXPLOSIVES IN AGRICULTURE

Two pear trees planted in the spring of 1913 and photographed in August, 1914. The one at the left was planted without blasting, while with the one at the right the treatment was used. The difference in growth shows the value of dynamite in agriculture.



MAKING WALL AND FLOOR TILE

One of the many uses of muriatic acid is in the preparation of potters' clay for the making of all sorts of tile and pottery.

CHAPTER IX

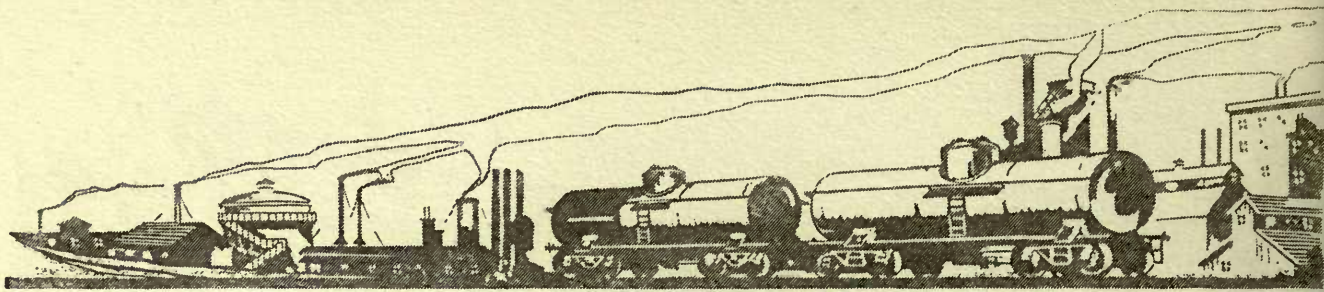
Chlorine

The Use of Chlorine in the Development of Modern Bleaching

FOLLOWING the chemical cycle from sulphuric acid to muriatic acid, we get chlorine from muriatic acid. Chlorine is an element, a greenish-yellow gas, of a pungent and suffocating smell. While it is secured from muriatic acid by combining the hydrogen in the compound with oxygen, leaving pure chlorine, it also is obtained by other methods, namely, the ammonia-soda process of alkali manufacture and by electrolyzing sodium and potassium chlorides. It is by the last named method that most of the commercial chlorine is obtained.

Chlorine is liquified under cold and pressure and shipped in small tanks inside wooden box cars. It may be handled in large tank cars of special construction, the tanks having been tested to a pressure of 360 pounds to the square inch.

Chlorine is used in the working of gold into manufactured articles but it plays a far more important part in industry in the manufacture of bleaching powder. Indeed,

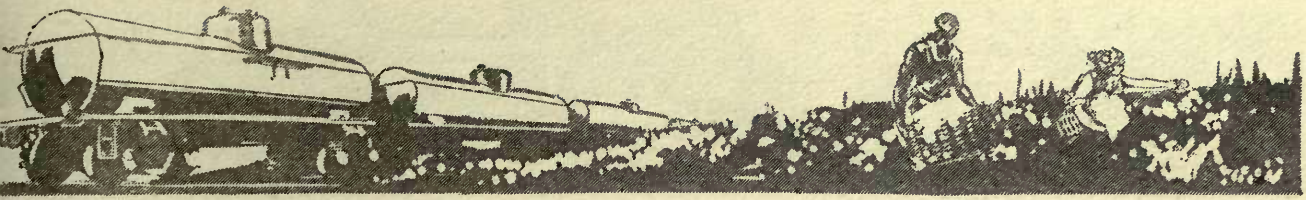


it was first introduced in industry as an adjunct to bleaching and its addition there revolutionized that industry.

Bleaching is not only applied to textile fabrics, but it is used to whiten paper pulp, beeswax, certain oils and other substances. Without the bleaching of textiles, however, womankind—and mankind, too—would be denied the vanity of gorgeous raiment, for cotton, wool, silk, flax and the like are saturated with foreign matters which must be removed to make them white and prepare them for the dyeing that will give them color. Without bleaching the housewife would be deprived even of white linens.

Bleaching undoubtedly is as old as civilization itself, because of the obvious fact that continuous washing and exposure to sunlight of a fabric cleans and whitens it. We know that in the day of the glories of ancient Egypt, her white and colored linens were in high repute; and the Phoenicians must have had a rather perfected process for bleaching, since the fame of their brilliant purples has come down to us.

Up until shortly before Americans ceased to be colonists of the British Empire, Holland had a virtual monopoly of bleaching. The brown linen of the British Isles was sent there in March and was not returned until October. The Dutch method was first to steep the cloth in waste lye and then give it a week's treatment with boiling potash lye. After that the cloth was washed and put under pressure in buttermilk for five or six days, when it was taken out and spread upon the grass for exposure to sunlight during the summer months.



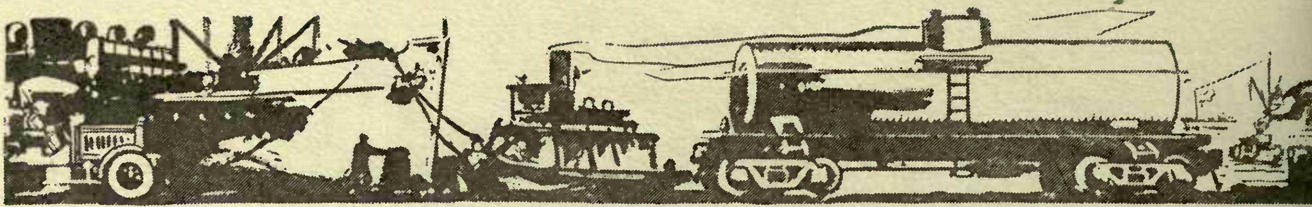
The treatment of flax was cruder still in Scotland. They steeped it in cow's dung for the "souring" process, and wool was treated in stale urine.

The first step toward modern methods was the substitution of dilute sulphuric acid for the sour milk. It raised a storm of protest on the grounds that it would injure the fabrics. Then came chlorine, through the discovery that it would destroy vegetable coloring and take the place of the long treatment by sunlight. Yet it was not very successful at first because of prejudice against its effect on the cloth and also because of the difficulties of working with the dangerous chlorine gas. In 1799, Charles Tennant, of Glasgow, introduced chloride of lime, or bleaching powder. The hazards of using chlorine were removed, and all the essentials of modern bleaching were available.

The treatment of cotton, wool, linen, silk and the other textiles all differ, both in method and in the machinery employed. Nevertheless, the principles necessarily are the same and modern machinery has eliminated the tediousness of nature's slow processes.

The production of chlorine from muriatic acid depends on the oxidization of the acid, the usual agent being manganese dioxide. Bleaching powder is then prepared by the absorption of the chlorine in lime. The reactions in bleaching are secured by the effect of sunlight, or by warming.

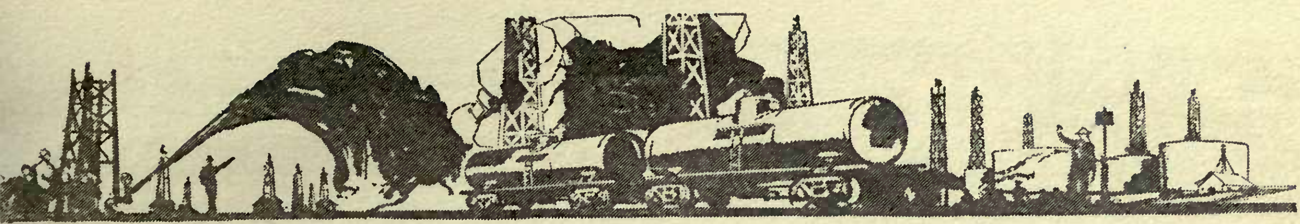
The great demand for chlorine has led to its preparation as a by-product in the ammonia-soda process of alkali manu-



facture. Essentially, this process is the breaking up of salt by subjecting it to an ammonia vapor and carbon dioxide.

The modern electrolytic process is to pass a current of electricity through common salt brine. The chlorine gas at once arises, leaving a residue of caustic soda. The gas is condensed into liquid chlorine and the soda is purified for commercial use. During the closing days of the war, the government was producing 100 tons of chlorine and 112 tons of caustic soda a day at the Edgewood Arsenal. Great quantities of chlorine were needed for toxic gases and the plant at Edgewood is the largest chlorine and caustic soda factory in the world.

Bleaching liquids also are made direct by the electrolytic process but they have in no wise supplanted the bleaching powder made from chlorine and lime.



CHAPTER X

Caustic Soda

Its Service in the Manufacture of Many Products and as a Sterilizer

THE modern method of manufacturing caustic soda is the electrolytic process, as explained under "Chlorine." However, older methods of alkali manufacture still are employed to some extent. The oldest is the Leblanc process, invented in France in 1791, which was the first method provided to get soda and potash from their salts.

Before Leblanc's invention the world's sources of soda and potash were confined to wood and seaweed. Leblanc won a prize from the French Academy but later died by his own hand in a workhouse, with no material reward for his great idea. While his process is more or less obsolete today, still he was the first to give the world materials for cheap soap, cheap glass and cheap bleaching.

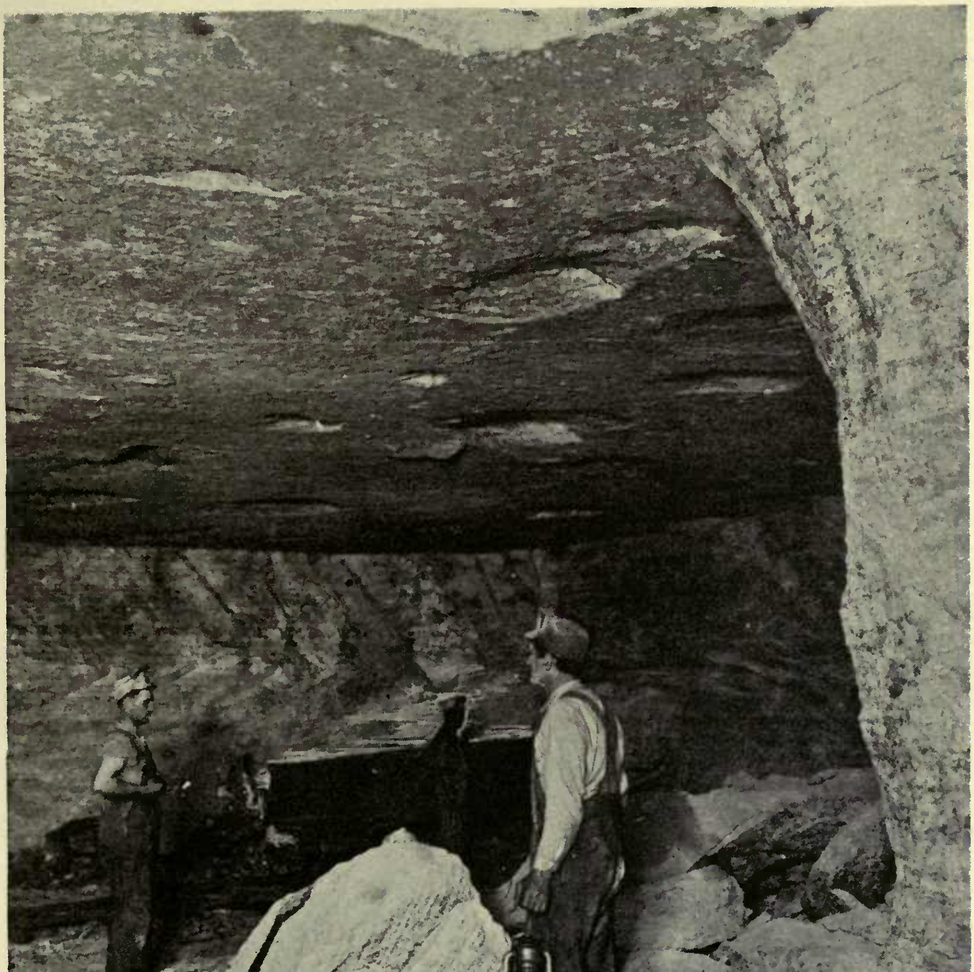
Another method of manufacturing caustic soda is the ammonia-soda process.

All three processes—the Leblanc, the ammonia-soda and the electrolytic—aim at the same thing, that is the breaking

up of salt. The first two require a complicated chemical treatment of the salt while electrolysis divides the salt into the desired products almost directly. Through the development of cheap electric current from water power, it also has become the most economical.

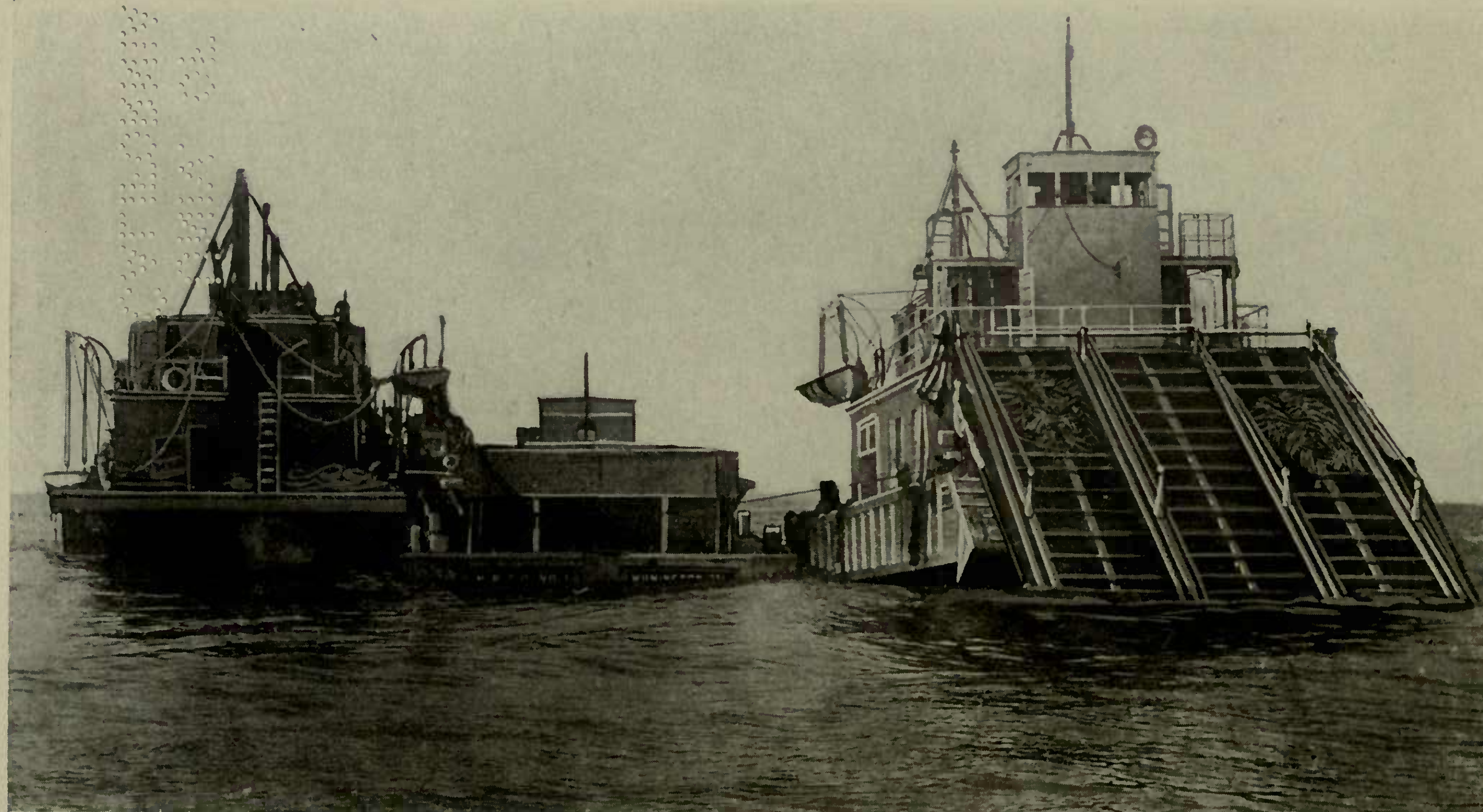
Pure caustic soda is a crystalline solid, but it readily dissolves in water and is handled in tank cars in a weak solution.

The part it plays in the manufacture of soap is explained under "Soap." It also is used in the manufacture of paper textile fabrics, in the preparation of alizarin dyes and of other coloring matters, in purifying gasoline and other oils and liquids, and as a sterilizing agent.



A KANSAS SALT MINE

You may think of salt only as a condiment, but from it we get materials for soap, glass and bleaching powder. Two salt products employed in these industries and transported in tank cars are chlorine and caustic soda.



Courtesy Hercules Powder Co.

HARVESTING KELP ON THE PACIFIC COAST

This motor-driven harvester plies through the sea with cutters operating down under the water and an endless belt carrying the kelp onto the deck. At the kelp plant this seaweed first is fermented in vats and then heated to an extreme temperature in kilns. The fine carbon it produces is purified by filtration and treatment with different chemicals, each of which produces a different by-product, and finally pure white potash is secured.

CHAPTER XI

Potash

The Great Demand for Potash and the Recent Efforts to Increase Production in the United States

POTASH has a considerable use in industrial chemistry, but it is most valuable as a fertilizer. What is meant by potash in chemistry is potassium carbonate. It is handled in two forms; hydrated, which is combined with water, and calcined, which is dried through heat. The potash for fertilizer is in the form of potash salt.

Potassium carbonate is used in the manufacture of glass, in the place of sodium carbonate, and in the making of chromates of potassium, salts employed in the chrome process of tanning leather. Caustic potash, which is produced from potassium carbonate in the same way that caustic soda is prepared from sodium carbonate, is in demand in the making of soap, especially certain soft soaps.

If potash products instead of soda products are desired in alkali manufacture, the change is made by substituting potassium chloride for sodium chloride, or in other words, potassium salts for sodium salts. But until recently Germany virtually had a monopoly of potash manufacture,

principally on account of possessing superior raw material. Practically all potash used in this country was imported from Germany. Our imports amounted to about 1,000,000 tons a year.

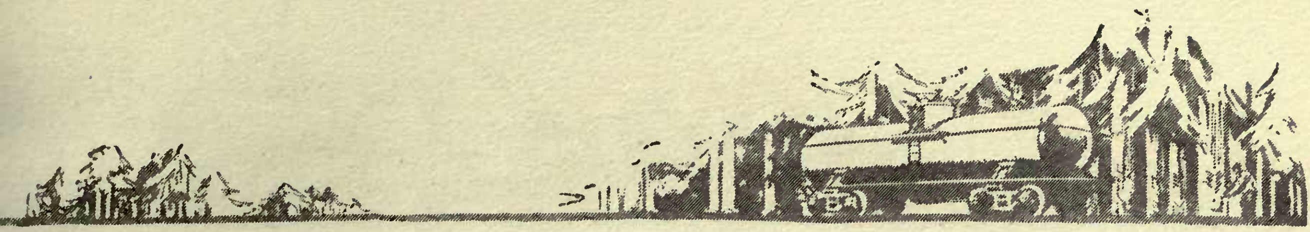
The war, however, brought a great change. Under stimuli from the United States Government, great efforts have been made to manufacture our potash supply in this country. Despite many difficulties, considerable success has been attained, although the shortage still is acute.

Potash is vital to the production of suitable truck vegetables of the South and a lack of it results in a decrease in the production of cotton and corn. Where the soil is weak in potash deposit, all crops suffer. Potash is taken out of the soil and assimilated in the growth of plants.

Most of the potash produced in this country is supplied by natural brines. A number of small shallow lakes in the sand hill region of Nebraska have been found to contain paying deposits. The sub-surface sands are impregnated with brine and pumped into plants for treatment.

The largest plant in the country is at Searless Lake, California, operated by the Trona Corporation. Other plants are located there also. Searless in reality is not a lake but a salt incrusted valley floor, covering approximately twelve square miles. The salt is deep and it is estimated that it contains millions of tons of potash.

The Salduro Salt Marsh of Utah, covering 125 square miles, resembles Searless Lake, and preparations are under way to work that deposit. Deposits of alunite near Marys-

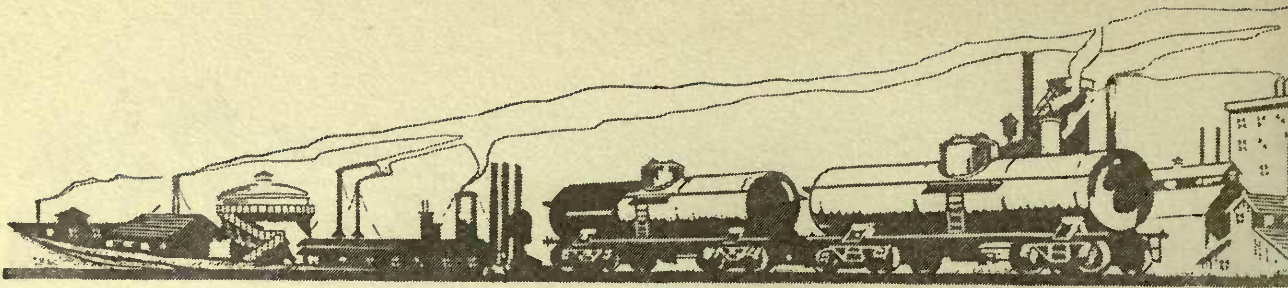


vale, Utah, also are being worked for potash. Another source is the great Salt Lake of Utah.

Some potash is being secured from the dust incurred in the manufacture of cement, and small quantities are a by-product of the making of explosives. Wood ash, molasses residue and many other materials contain small amounts. Feldspar and other silicates are being worked for it. Gold probably is not sought more eagerly than commercial quantities of potash.

The kelp, a seaweed, which grows in great quantities along the Pacific Coast, has long been known as a valuable fertilizer, and now potash is being produced from it to the extent that the quantity is second to that from brines. The Hercules Powder Company has a plant in California which consumes great quantities of kelp, from which is produced potassium chloride, acetone, iodine and ethyl products.

Handled in a weak solution, potash is not injurious to tank cars.



CHAPTER XII

Acetone

The Employment of Acetone in Explosives and as a Solvent

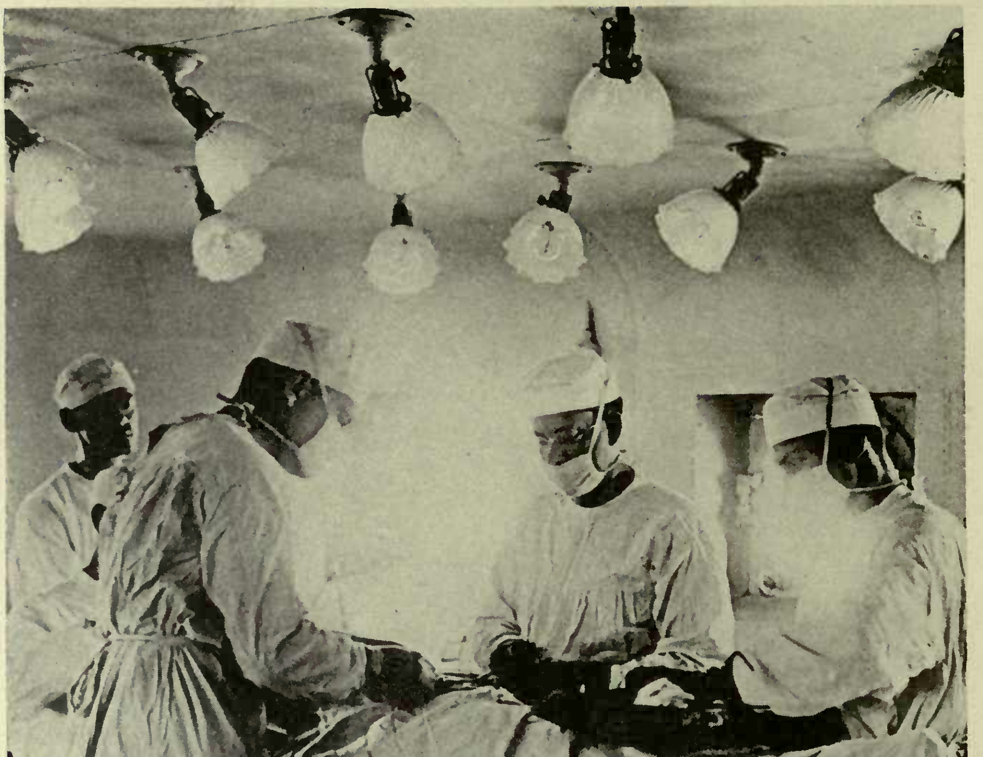
WE have seen how acetate of lime is obtained in the process of distilling wood alcohol. From it acetic acid is obtained. Some acetone may be procured in this process of fractional distillation, but on a large scale it is prepared by the dry distillation of calcium acetate. Another method of manufacture is by the passing of the vapor of acetic acid through pumice and precipitated barium carbonate. The crude acid may be purified by further chemical combinations and distillation.

The most important use of acetone is in the manufacture of cordite, an explosive. To secure this product the crude acid is distilled over sulphuric acid and fractionated. Acetone also is used to produce chloroform and sulphenol and as a solvent. It has a considerable value in the manufacture of a number of chemicals, such as artificial indigo and iodoform.

Acetone is a colorless mobile liquid with a pleasant odor, but it has a biting taste and is very inflammable. It is another of those chemicals whose transportation would be a perplexing problem except for such refinements as are provided in Standard Tank Cars.

TANK CARS IN FRANCE

This congested freight yard at Lyons, France, pictures the tank car in evolution. Over there wood tank cars still are used, especially in the transportation of wine. Here we see them in the same trains with steel tank cars.



ANAESTHETICS IN THE WAR

A photograph of an actual operation aboard the Hospital Ship Mercy during the war. Tank cars are used to ship ether and the materials from which it is made, ethyl and methyl alcohol.

CHAPTER XIII

Ether

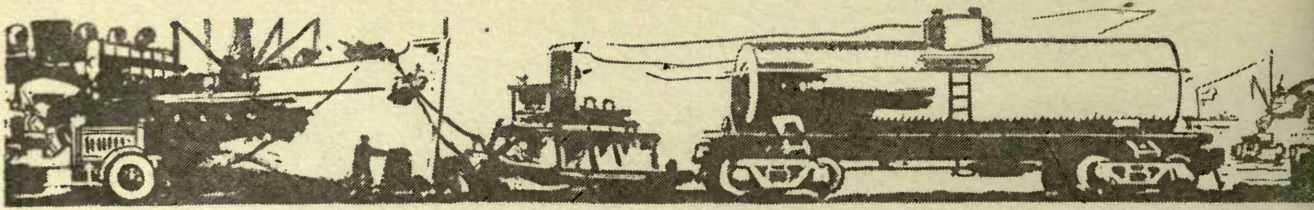
An Anaesthetic, and an Ingredient in Smokeless Powder

ETHER may be obtained from both ethyl and methyl alcohols by removing part of their water content. The principal method of manufacture is through the action of sulphuric acid on alcohol. Alkyl sulphuric acids are formed first and then the addition of more alcohol and heating produce ether. Ether is a very volatile liquid. It has a pleasant odor and boils and burns easily.

Other acids may be substituted for sulphuric and many variations made in applying them for the making of ether.

As pointed out in the chapter on "Alcohol," it is used in surgery as an anaesthetic, in the preparation of smokeless powder, in collodion, and in the manufacture of artificial silk.

It is one of many commodities that must be carefully handled in tanks, since it evaporates rapidly at a low temperature. However, it is readily soluble in water, and in this form may easily be transported in the proper type of Standard Tank Car.



CHAPTER XIV

Ammonia

The Use of Ammonia in Refrigeration

AMONG the many things that distinguish the American mode of living from the European is our common use of ice. Especially does America lead the nations of Europe in methods of refrigeration by which fresh meat, vegetables and other foodstuffs are transported great distances. In the single instance of cattle raising, refrigeration is as necessary to the maintenance of a profit in beef as the very foodstuffs of the cattle. And ammonia processes are the principal methods of refrigeration and in the manufacture of ice.

It is too much of a thought to consider what we would do in this country if we had to go back to the early methods of refrigeration, such as the old spring and the well. With prohibition sweeping the country, there would be no cooling soft drinks at soda fountains to quench thirst, to say nothing of our supplies of fresh meats, fish, vegetables and fruits. Yet the principles of modern refrigeration virtually are the same as in those days when life in America was centered about the farm.

Refrigeration simply is the cooling of a body by the transfer of a part of its heat to another and cooler body. Heat is

KEEPING FISH FRESH

The preservation of foodstuffs by refrigeration is a vital part of our economic life. Tank cars handle great quantities of ammonia for use in refrigeration.

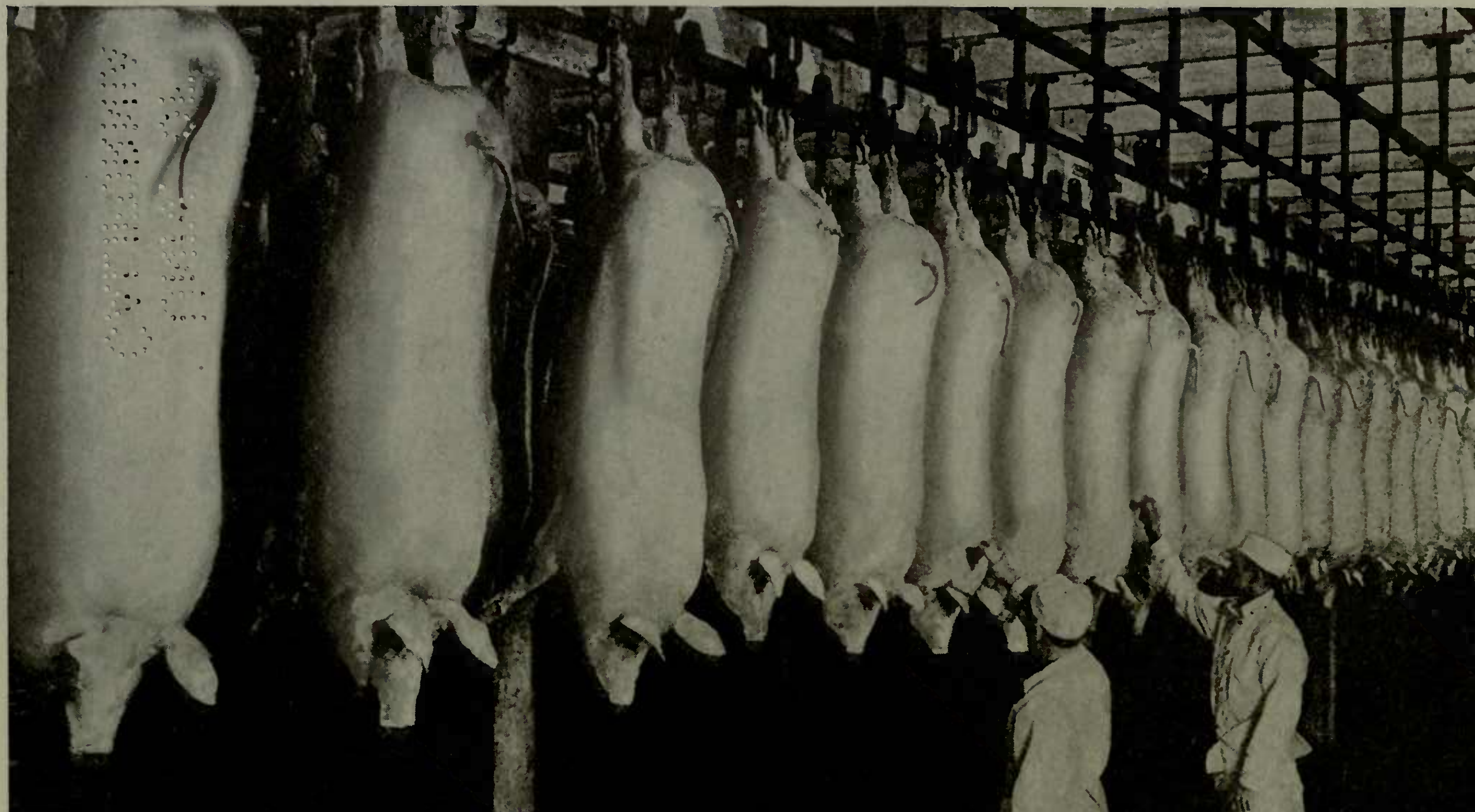
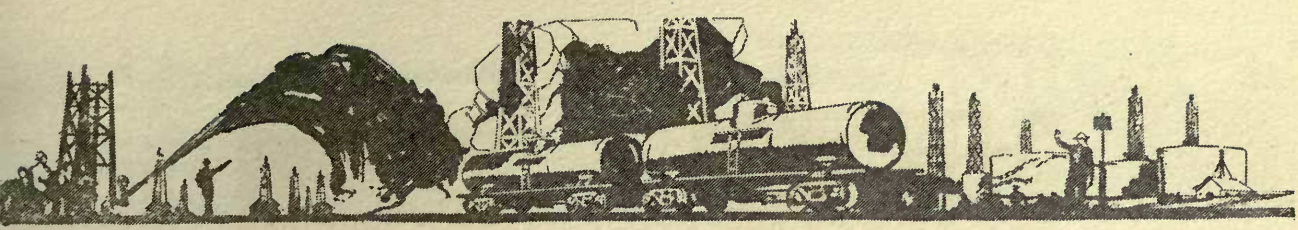


Photo from U. S. Dept. of Agriculture.

UNCLE SAM'S SEAL OF APPROVAL

Only modern refrigeration has enabled the packers to come to handle three-fifths of the country's meat supply. The hogs have been hung in a cold-storage room of a big packing plant and are being inspected by agents of the United States government.



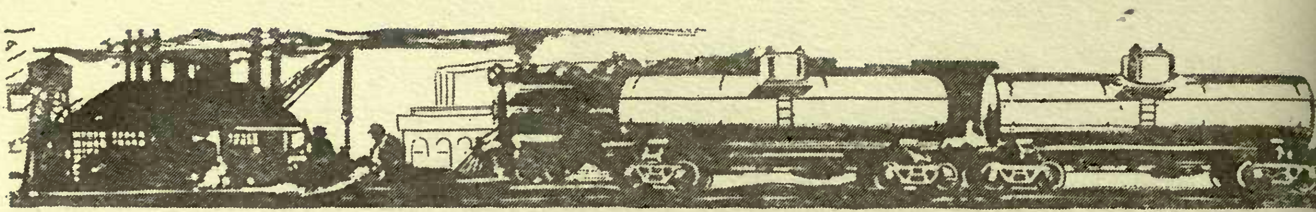
a positive while cold is a negative. There are a number of methods of applying the principle, but we will consider only those in which ammonia is used, which, after all, are the ones most generally employed.

First, let us trace the source of ammonia.

It is a distillate and its sources are widely scattered, from stable manure to the very air we breathe. It was first secured by the action of alkalis on ammonium salts. These salts are found in volcanic districts. Later it was obtained by distilling horns and hoofs of cattle and neutralizing the resulting carbonate with hydrochloric acid. These same principles are still employed, but a practical method of producing large quantities is from the ammoniacal liquor of gas works. Ammonia also is found in small quantities as a carbonate in the atmosphere, being produced from the putrefaction of nitrogen and animal and vegetable matter. Small quantities may be secured from this source by an electrical process.

Long ago, it was discovered that the change of form of a liquid to a gas requires heat. The more volatile the liquid the lower its boiling point, and, therefore, the more easily would the process absorb heat from surrounding bodies.

Liquid air boils on ice but liquid air can be obtained only under high pressure. Water requires a high boiling point to change it into steam. The discovery that the reduction of pressure on water lowers its boiling point led to a search for a more volatile liquid for use in refrigeration. The employment of a vacuum process for reducing air pressure



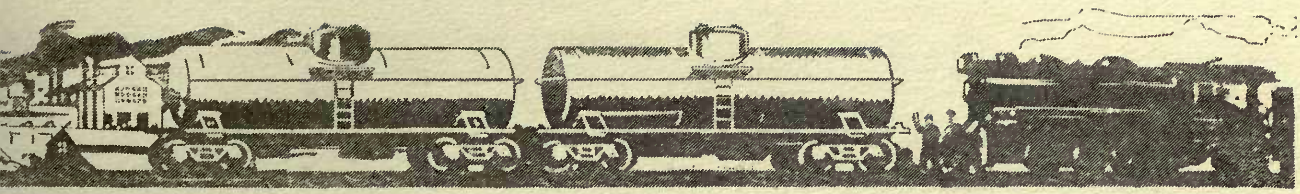
on water requires too great a mechanical efficiency. Ammonia, being more volatile and comparatively cheap, was found to be a satisfactory liquid.

There are two general types of machines in which it is employed in refrigeration and in the manufacture of ice. They are "compression machines" and "absorption machines."

A feature which is the same in both is that the matter to be cooled—water, air or brine—surrounds the refrigerator in which the ammonia is evaporating. For both, the machinery throughout is very similar. The difference is that in the compression system the evaporation is conducted by maintaining a lighter pressure and higher temperature in a refrigerator than in a connected condenser; while in absorption it is done by the introduction of heat through steam coils and the propensity of water from which this heat has expelled ammonia to absorb more ammonia. In the latter an absorber is connected with a refrigerator and the mechanism so arranged that there is a continuous flow of ammonia gas from the liquid ammonia in the refrigerator to the water in the absorber.

The mechanism of both is such that none of the ammonia is lost, but is in each condensed and automatically continued through the same process.

In the manufacture of ice the water to be converted is placed in contact with pipes containing ammonia vapor or brine. In cold storage plants and in the refrigerators on ships, either air is cooled and shot into the space or pipes containing cold brine are used. The two sometimes are



combined. But to be effective cold storage rooms must be so insulated that heat may not penetrate.

The system is simplified by the fact that the colder the air the heavier it is, and if the openings are at the top a room will hold cold air as a glass holds water. This is easy to arrange in the holds of ships and it has been found economical even in cold storage warehouses.

Refrigeration is indispensable to most ocean traffic. Thanks to it, meats, fish, vegetables and fruits are kept fresh to be distributed throughout the world. No city could have pure milk without it, and much of the food supply, such as eggs, for instance, is stored in the season of plenty for future use. Refrigeration enters largely into the great meat packing industry of this country.

Ammonia has a wide use in drugs. It has an extended application in industrial chemistry, as illustrated in the ammonia-soda process of alkali manufacture. Also it is used in the preparation of explosives.

Ammonia is a strong liquid and is severe even on tank cars. As a precaution, Standard Tanks in which it is shipped often are coated on the inside with an acid-resisting paint, such as litharge.

CHAPTER XV

Explosives

The Part of Explosives in the Pursuits of Peace; Liquids that Go To Make Them

WHILE the uses of the various liquids handled in tank cars are discussed in this book under the head of each, it is well to group here those which play essential parts in the manufacture of explosives, and point out the importance of this industry.

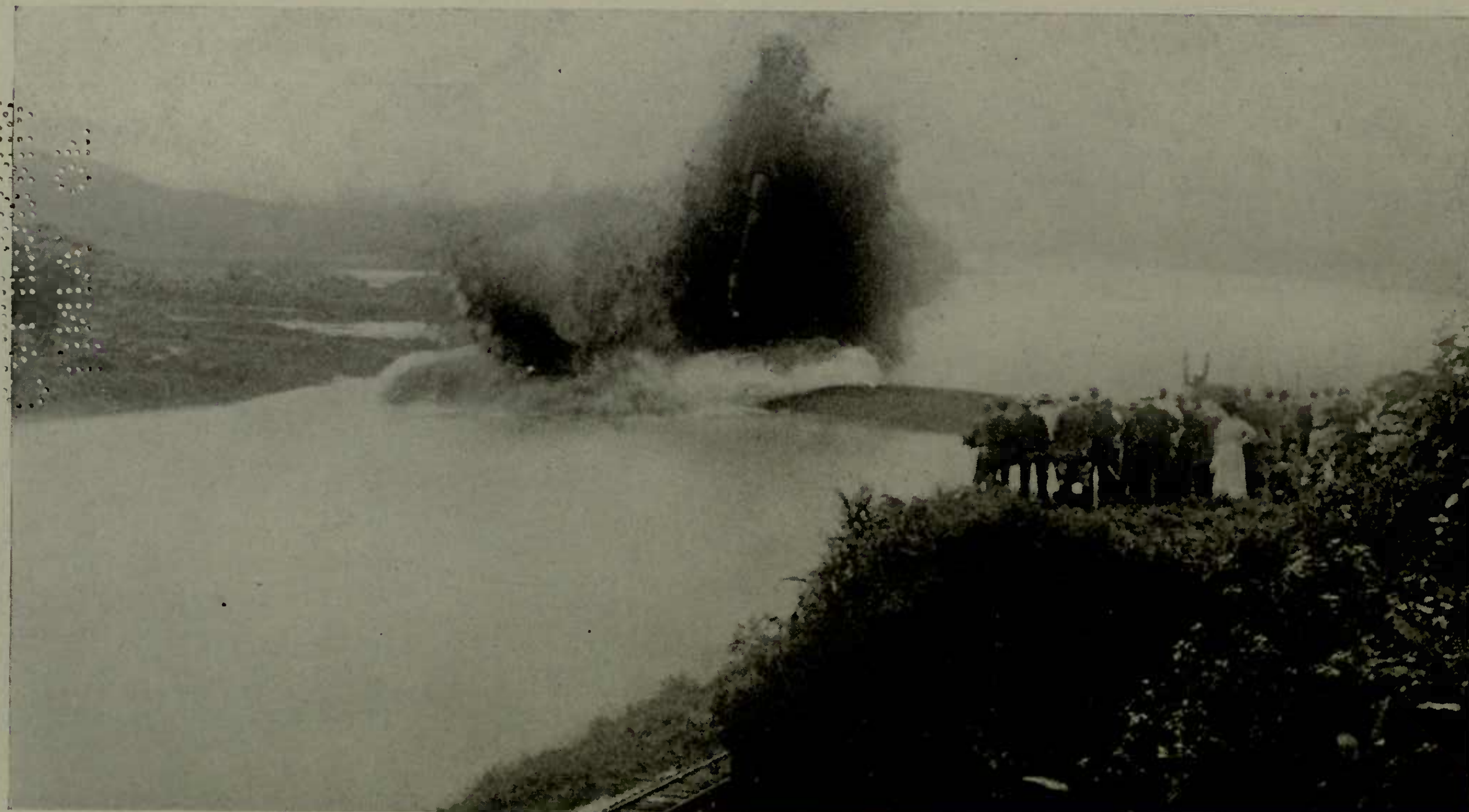
The liquids included are: acetone, alcohol, ammonia, benzol, toluol, carbolic acid, nitric acid, glycerin and sulphuric acid.

With so much of the thought of the day occupied with the war and its aftermath, explosives instantly suggest their use exclusively as munitions. The manufacture of explosives would be a hectic sort of industry if its products depended on their use in battle. Their vital part there is generally understood, of course, but their part in the pursuits of peace is just as great.

The world's greatest engineering feat—the digging of the Panama Canal—never could have been accomplished without explosives for blasting. America's railroad system,

HELPING MAN REMODEL THE WORLD

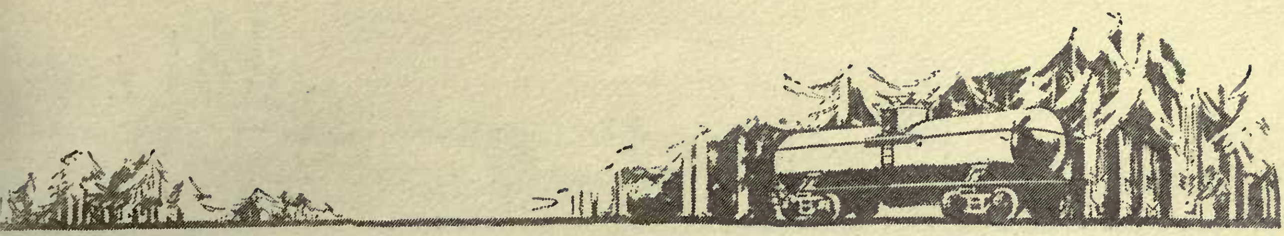
Back of the Panama Canal that was blasted through the backbone of a continent; in opening great mines into the riches of the earth; in building railroads which have created new empires; in bringing forest and desert land under agriculture, is the service of the tank car in transporting liquid chemicals with which explosives are made.



Courtesy E. I. DuPont de Nemours & Co.

COMPLETING THE PANAMA CANAL

Gamboa, the last Panama Canal dike, was removed when President Wilson, in Washington, set off a 40-ton blast of dynamite. Tank cars had a part in this historic accomplishment, for they had handled the ingredients of the dynamite.



spanning hills and mountains, could not have been constructed with pick and shovel alone. It is estimated that the farmers of this country use 25,000,000 pounds of dynamite each year in clearing lands, draining swamps, planting trees and breaking up impervious subsoils. Explosives are an indispensable part of the materials for coal mining, and also for the extraction of the precious metals from the earth. They are employed in the preparation of the foundations for the great buildings in our cities, in all the great quarries and in countless other important works.

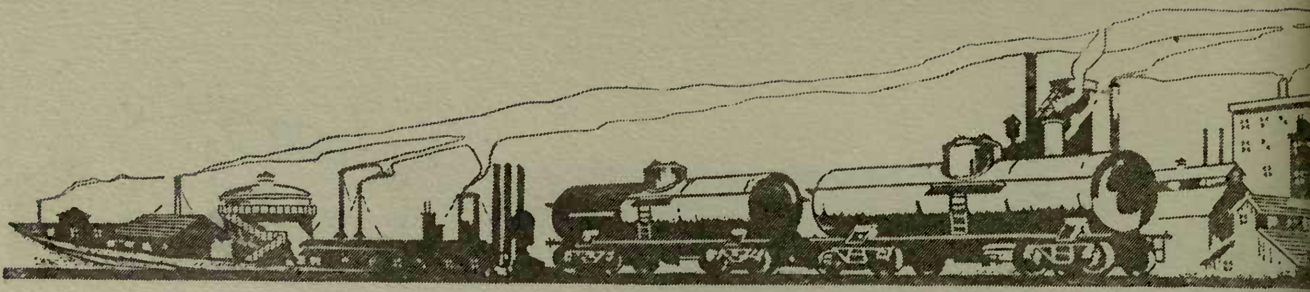
Great mills are required for the manufacture of explosives, but fundamentally the processes are chemical.

The most valuable of modern explosives are the smokeless propellants, the propellants being the type of explosives with the property of sundering bodies about them. Most propellants are nitrates, that is, combinations from nitric acid. Among the smokeless propellants, the combinations of guncotton and nitroglycerin lead the field. This product was invented by A. Nobel, the donor of the famous prizes.

Guncotton is made by immersions of pulp from pure cotton in nitric and sulphuric acids. The perfecting of it for use in smokeless powder is attained by partial dissolution in acetone or in certain benzene compounds.

Nitroglycerin is made from nitric acid and glycerin, and is a principle component in dynamite.

Alcohol, as has been explained, is used to form fulminates. Ammonia is employed principally in preparing



ammonia nitrates, but it also is applied in the making of a number of other important explosive materials.

An old and simple propellant is nitrobenzene, a combination of nitric acid and benzene.

Carbolic acid is the source of picric acid and other high explosive elements.

Toluol, or toluene, combines with nitric acid to make nitro-toluenes, which are used with certain ammonium nitrate explosives and to lower the freezing point of dynamite. Several million pounds are used each year in the manufacture of low-freezing dynamites.

T. N. T. (trinitrotoluene), one of the most famous explosives of the Great War, is a combination of nitric acid and toluene and is typical of the important nitrotoluene explosives. A quality of great value in T. N. T. is that it is not sensitive to shock.

From naphthalene and nitric acid certain explosives are made that are particularly suitable for coal mining.

The various ingredients from coal-tar which are employed in explosives are used to impart some particular characteristic. The principal ones used are benzol and toluol. They must be of a high degree of purity to prevent the formation of products of inferior stability.

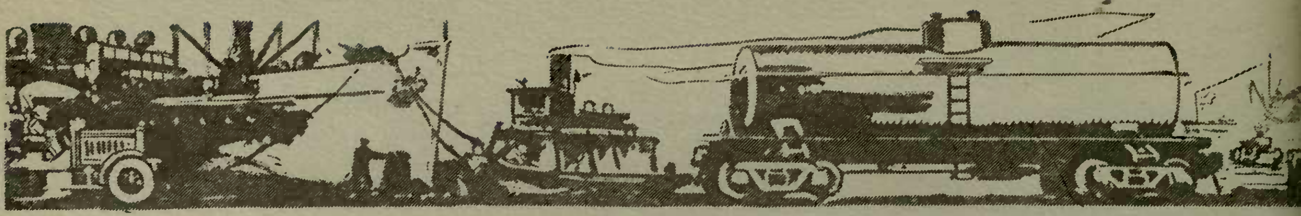
CHAPTER XVI

Tannic Acid

Processes in the Making of Leather

A MAN who goes into a store to get a suit of clothes usually buys by pattern and fit; the texture of the goods he considers beyond his sphere. But let him consider the purchase of a traveling bag, a pair of shoes, or a saddle, and watch how he feels the leather and studies its grain. When it comes to leather, every man considers himself an expert.

In taking up the study of tannin, or tannic acid, we are considering that commodity which converts rawhide into leather. The interest of the average man in its products is developed to a high degree in the horseman, the army officer and types whose vocations bring them into a more extensive use of leather. They learn that it has a life that soon will die, unless properly cleaned, oiled and polished. In short, they practice in the care of leather the same principles that enter into its manufacture from the raw skins. The skins, in a raw state, are readily putrescible, and if dried become hard and intractable. They must be tanned with acid; they must be oiled and dried, and made pliable, and to keep them in proper condition after they have been made into shoes or



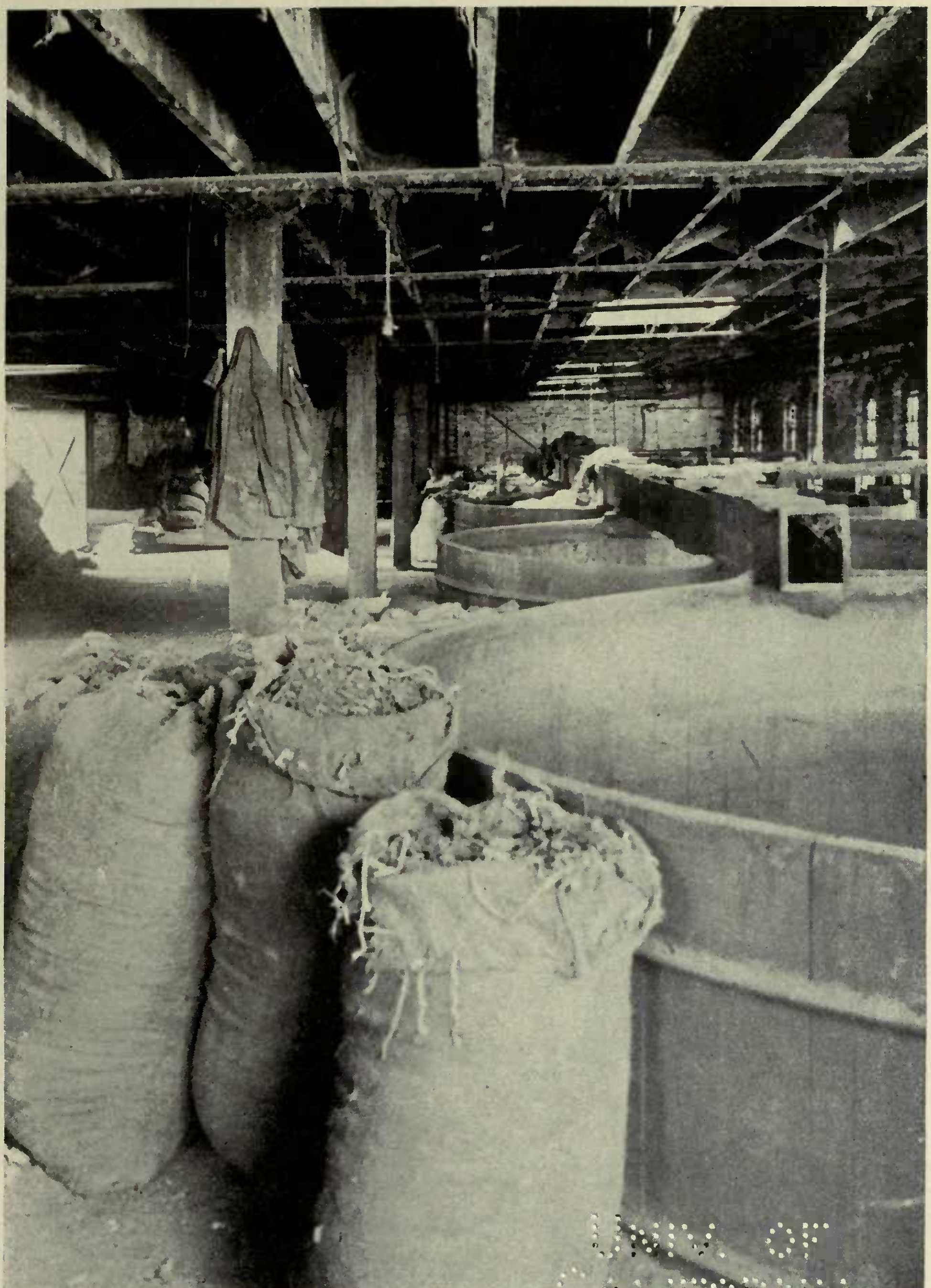
harness, a treatment with oil must be continued. There is no doubt that the cave man, who clothed himself with the hide of a goat or leopard, knew something about tanning skins, else he had a most horrible apparel in addition to his other discomforts.

The sources of tannic acid are abundant in nature. It is found in the bark, wood, roots, fruits and leaves of many plants. Among the American sources are chestnut, oak-wood, white birch and willow bark, galls, oak bark and sumach. Oak bark produces the best leather known. The gall nuts are the familiar abnormal growth upon oaks. They are caused by the gall wasp laying its eggs in that part of the tree, and they contain from fifty to sixty per cent of tannin. The tannic acid from them largely is used in the manufacture of inks and dyes rather than in tanning leather. It is easily soluble in water, the compound making a dark blue or green liquid.

The most useful and most plentiful tannin is secured from sumach. It produces an almost white and very beautiful leather that is used extensively for book bindings and similar fine leathers.

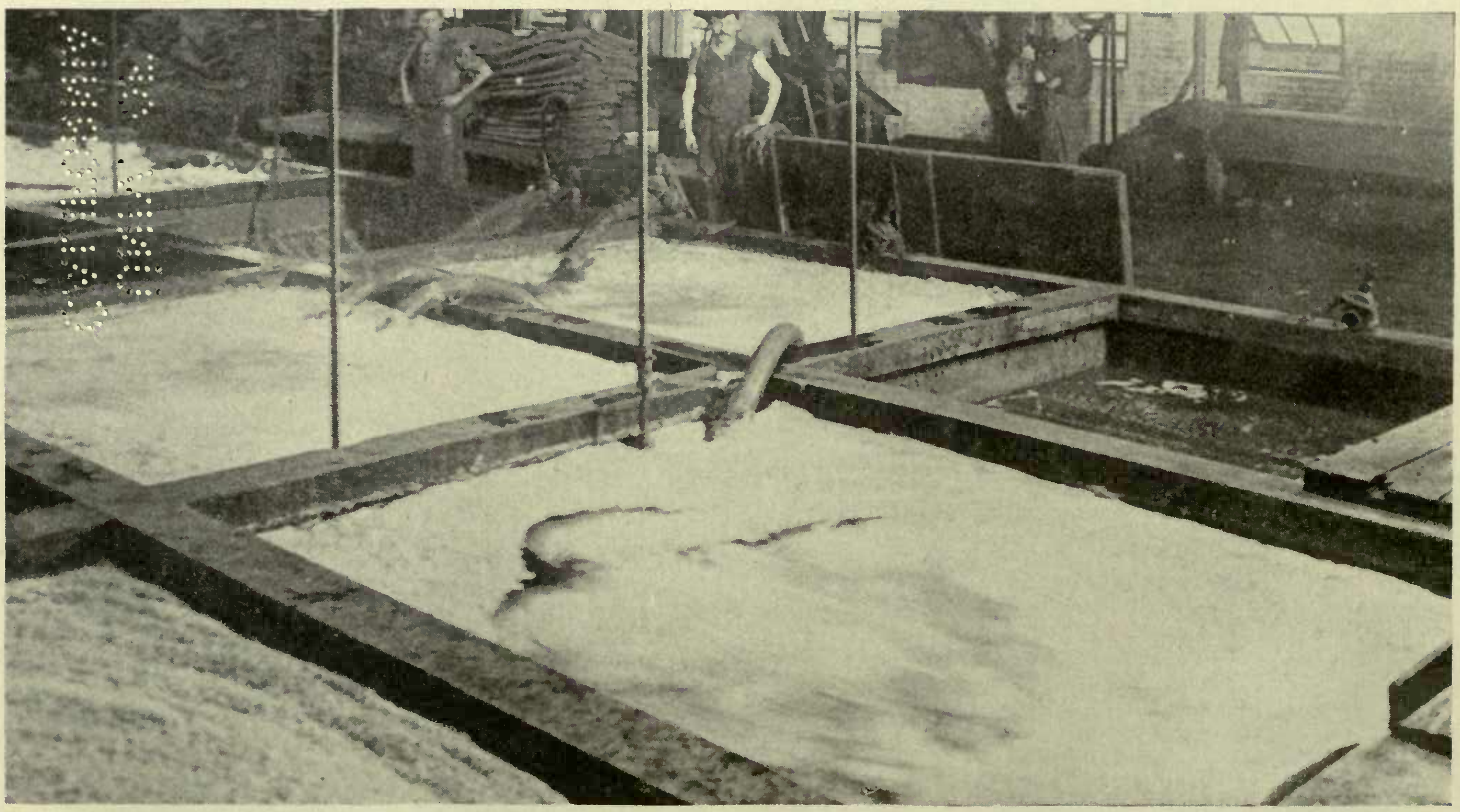
Sumach grows plentifully on uncultivated land over a large part of the United States. It grows as a shrub, or small tree, and in many varieties. It is successfully cultivated to a small extent, but even the wild growth has not been exploited to anything like its commercial value.

The quality of all tannic acid is determined to a great extent by the degree of whiteness to which it will bring



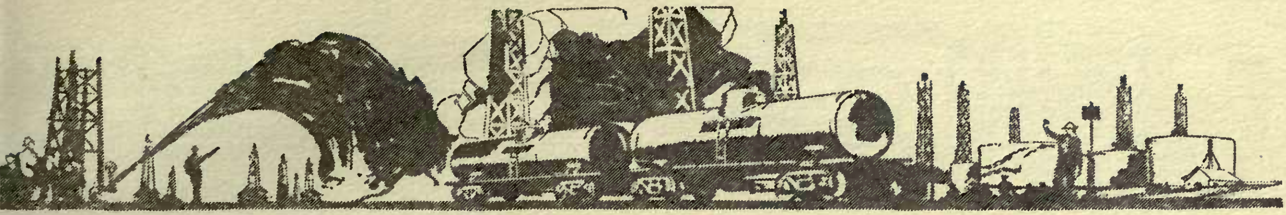
MAKING TANNIC ACID

Bark and wood from various trees and plants are ground up and leached in vats of water to make tannic acid. The acid, another of the important commercial liquids transported in tank cars, is used to convert rawhide into leather.



VATS FOR TANNING LEATHER

In the making of leather, hides are treated in a series of vats of tannic acid of varying degrees of concentration. The acid has both a chemical and physical effect on the hides, making them waterproof and determining the hardness of the leather by its strength and the length of time of its contact.



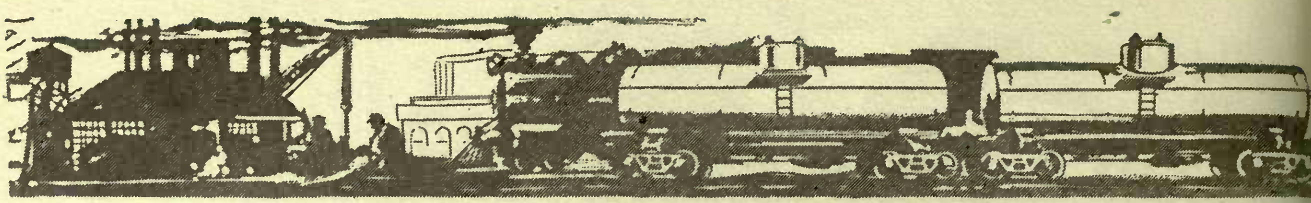
leathers. The usual procedure of the tanner is to combine two or more of them, for in general they all have the same qualities.

While the acid to some extent is free in plants, most of it is contained in cells. To produce it, the leaves, or bark, or wood must be thoroughly ground and bruised so as to break the cells. This is done in "hog" machines, built somewhat on the principle of a coffee grinder. The mass is then put in water and the liquor that results is what is known as tannin, or tannic acid.

The action of the acid on the skins is chemical and physical. It works as a powerful astringent and forms an insoluble gelatinous compound within the leather which affects its hardness and makes it waterproof. Thus the extent of treatment of the hides with the acid determines the quality of leather which will result; sole leathers and the like being given much stronger treatment than light and fine leather.

A series of pits of the acid solution, of varying degrees of concentration, are arranged so that the hides may be treated as desired, the periods of immersion varying from days to weeks. In addition to the solution, vegetable "dust" is sprinkled on the hides for mellowing.

Hides come to the tanner in all sorts of conditions. Some are covered with blood and dirt, others are salted, and still others have been dried in the sun. Before they are subjected to the tanning process, they must be cleaned and as nearly



as possible restored to the flaccid condition in which they came off of the animal's back.

The first work then is soaking and cleaning. Caustic soda and sulphuric acid are used to advantage in this work. The next step is to remove the hair and swell the hides, that they may properly receive the tannin liquor. The hides are put through a series of solutions of lime and scraped with an unhairing knife.

It is at this stage that the actual tanning begins, being divided into three operations: coloring, handling and laying away. The concentration of the acid increases with each operation. The hides are first colored in a weak solution, then handled forward from weaker to stronger solutions, and finally deposited in a very concentrated solution for a period of perhaps two weeks. The "dusting" with mellow vegetable materials is done just before the goods are laid away; the softer the leather desired the more mellowing material being required.

The finishing process includes a scouring, a bleaching in sumach or some other similar liquor, oiling with fish oil, washing again, then rolling and being hung up to dry.

Currying is the next treatment given. It is not a part of tanning proper, but determines to a considerable extent the quality of the leather. It consists in working oil and grease into the leather to make it more pliable and to add to its strength. The action of the oils also is chemical as well as physical, its operation adding much strength to the leather. It is for this reason that only animal oils are suitable, the

favorites being whale and fish oils. Mineral oils act only as a lubricant.

The whole process for the making of the best leathers requires from seven to ten months. Frequently the time is reduced in the making of cheaper goods.

Another and more modern method for tanning leather is the chrome process. This is a substitution of a mineral for a vegetable tanning agent. Essentially, it is a partial chemical combination between the hide fibre and chrome salts. One of the solutions is potassium bichromate, muriatic acid and water. There are several similar combinations for the immersions.

The leather produced is much stronger than any other leather. It will stand boiling water while vegetable tanned leather will not.

Of commercial importance is a combination of the two methods. After leather has been tanned by either of the two methods, the liquors of the other will act upon it to some extent. The vegetable tanning gives leather a plumpness and resistance to water, while the mineral process will add a softness that can not be attained except by much currying.

There are many variations to tanning. There is what is known as iron tannage, through the use of ferric salts. For the making of chamois leather, oil tanning is carried out on much the same principle as currying. There are various patented processes for the making of special leathers. Parchment, for the printing of diplomas and similar things,

is made by a particular treatment of sheepskin. Then the lighter leathers are dyed in much the same way as textiles.

The best leathers come from well matured cattle that have lived their lives in the open. Stall-fed animals render inferior skins. This is said to be the principal fault with horsehide. Lighter and finer leathers are made from lower grades of cattle skins, split-hides, sheep and goat skins, horse-hides, and so forth. But all through the tanning process the details are regulated by the sort of finished product desired.

Tank cars haul the oils for the currying, muriatic acid and other liquids used in tanning, as well as the tannic acid. It takes great train loads of tank cars to supply the tanner with tannic acid. The cars in the tanning trade are coated on the inside with an acid resisting paint and equipped with at least two lines of brass coils. An added precaution is to have brass valves and outlet legs.

MOVING LIQUIDS ON THE NILE

Where tank car service is lacking, the moving of liquids becomes a great human drudgery. In the picture above men are carrying water in goat skins.

RAISING CASTOR BEANS IN FLORIDA

A patch of castor beans, raised to make castor oil for aeroplane lubrication. California is first and Florida second in the production of castor beans. The crop is rapidly increasing because of the development of air travel.

CHAPTER XVII

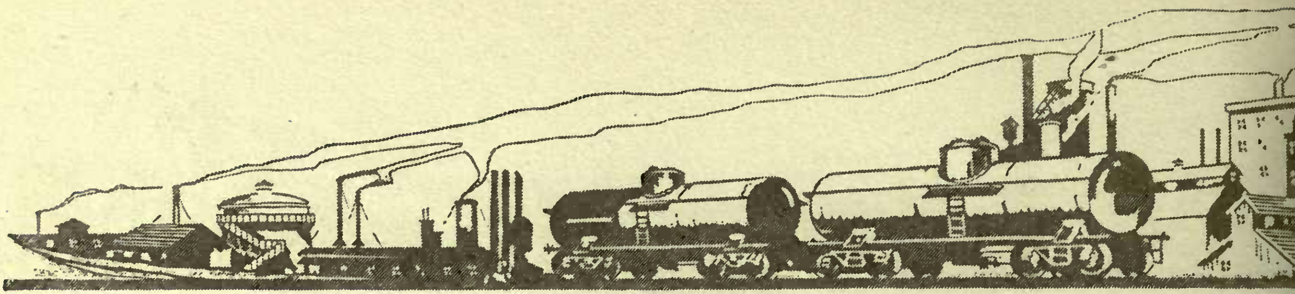
Castor Oil

A Medicine, and a Lubricant for Delicate Machinery

AN industry which has loomed large with the development of the aeroplane is the production of castor bean oil. Long valued for medicinal purposes and as a lubricant, it has been found to be most suitable of all the oils for the lubrication of the refined motors of the aeroplane and similar high speed machinery.

The castor bean plant is a native of tropical Africa but thrives anywhere in the warmer temperate climates. There are many varieties of the plant in cultivation. They vary from scrubby plants to trees of from thirty to forty feet in height. Because of the beauty of its leaves it frequently is cultivated as an ornament, the plants being readily grown from the seeds.

The bean has been grown and the oil manufactured on an extensive scale in California for some years. The demand for the oil as a lubricant for aircraft engines during the war caused the United States Government to encourage the cultivation of the plant, and quantities of the



bean were grown all over the southern section of the country.

For many years the oil has been an important import from the Orient.

The beans grow in a three-celled capsule with one bean to each cell. The oil is extracted by a screw or hydraulic press. It is then boiled with water, when mucilaginous matter collects on the surface as a scum and is removed. The water is drawn off, the oil strained and placed in tanks to be bleached. Then it is ready to be stored for shipment.

India easily produces great quantities of castor bean oil and there it is used for illumination. Castor bean oil is in great demand as a high grade lubricant. Often for this purpose it is combined with other vegetable and petroleum oils. Even before its properties as a lubricant were so well known, it was employed in the manufacture of imitation rubber and of plastic soaps.

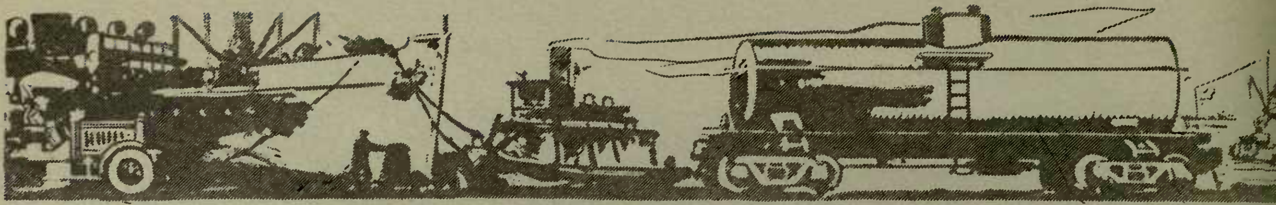
It is one of the best known and most extensively used purgatives, especially in cases of temporary constipation among children and the aged; but medical authorities advise it must not be used in cases of chronic constipation, for this it only aggravates.

Medical science has not yet determined exactly the principle of its purgative powers. It is considered probable that this is due to some decomposition that takes place inside the intestines. Doses are from a drachm to an ounce, and

because of the very nauseating taste, it is best taken in capsule or with fruit juices.

Castor oil is a viscid liquid but almost colorless when pure. Its beans are poisonous, having been known to kill adults.

A thoroughly clean Standard Tank Car with sealing devices insures a most satisfactory shipment of it.



CHAPTER XVIII

Cotton Seed Oil

How This and Other Oils Are Used in the Manufacture of Compound Lard and Oleomargarine

THE development of the manufacture and use of cotton seed oil is nothing less than a romance of industry.

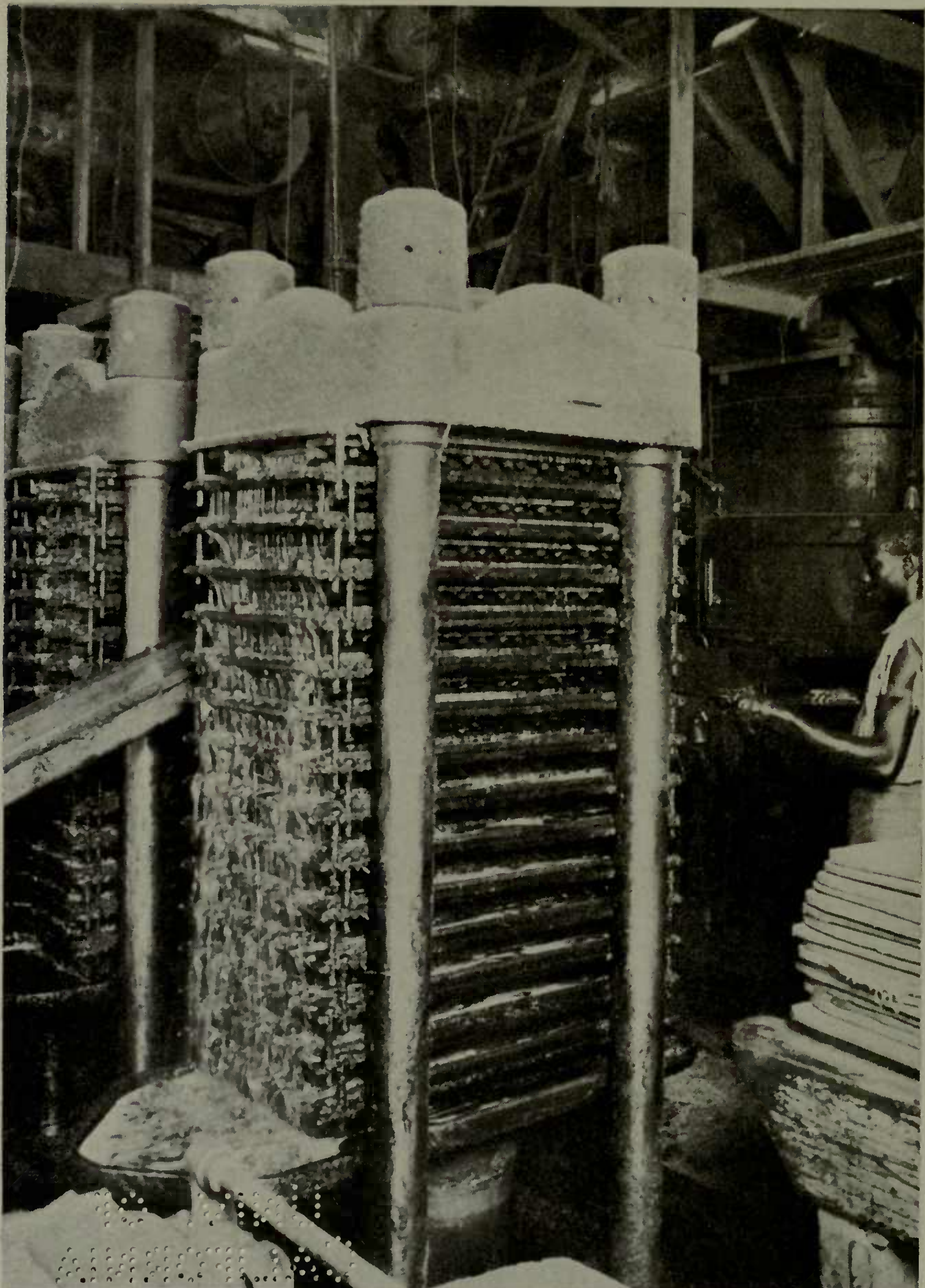
When we remember that in the South cotton is king, and that prosperity and wealth depend upon it, the discovery of the value of cotton seed was like finding the fabled pot of gold at the end of the rainbow.

Only a few years ago the huge annual volume of cotton seed was regarded as little more than a nuisance. After the planter had selected his seed for planting, his principal interest in the remainder of the seed was to find a place to dump it. An idea of the quantity is given in the fact that for every 500 pounds of cotton produced there are 100 pounds of cotton seed. To a limited extent the seed was fed to cattle and used as fertilizer, but the great proportion went to waste.

Today the seed is as carefully marketed as the staple itself. The cotton seed oil mills have given it a value formerly undreamed of.

COTTON IN FLOWER AND IN FRUIT

Here three interesting stages in the growth of cotton are shown—the blossom, the opening boll and the cotton ready to be picked. Hid in the fleecy white bed are the seeds from which the valuable cotton-seed oil is expressed.



A VIEW IN A COTTON-SEED OIL MILL

Cotton-seed oil is obtained by grinding up the kernels of cotton-seed and squeezing out the oil with the presses. It is used in the preparation of compound lard, oleomargarine and other foodstuffs.

The process of manufacture is to hull the seeds and press the oil from the kernels. The cakes, left after the oil is extracted, are ground into a greenish yellow meal, which has a high value both as a feed for cattle and hogs and as a fertilizer. The hulls are a good substitute for hay.

The oil is a heavy liquid, the most valuable of the cotton seed products. It is produced in great quantities in mills scattered widely over the cotton belt. The rich oil contains fatty solids which give it a tendency to solidify in cold weather. It is cleared of these particles by being chilled; the mushlike mass is then pressed and the solid matter removed. The oil secured is known as "winter yellow" and remains clear in winter weather. The original oil is known as "summer yellow."

Further refining is done, according to the purposes for which the oil is to be used. The winter yellow is prepared into substitutes for olive oil as an edible oil. The summer yellow is employed in the preparation of compound lard.

The lard is a compound of the summer yellow oil and oleo-stearine, frequently with a part of hog lard. Other vegetable oils—nut oils and corn oil—may be added or substituted altogether for the cotton seed oil. Oleo-stearine is the solid part of choice beef fat after the oil has been extracted. The process of boiling the fat and then extracting the oil leaves the oleo-stearine a solid mass with a tendency to crystallize. There is a wide variety in the proportions of the various oils in the final mixture. They largely are determined by the sort of finished product desired. The compound, after heating and thorough mix-

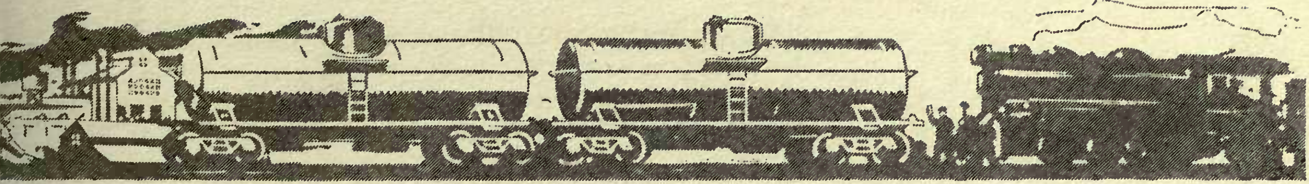
ing, is congealed by artificial cooling, and the compound lard formed is ready for packing for the market.

The oleo-oil extracted from the beef fat is used with high grade hog lard and other ingredients to make a butter substitute, known under the name of oleomargarine. This product was invented as a result of the siege of Paris in the Franco-Prussian war. The oleo-oil may be diluted with cotton seed oil, but such vegetable oils as cocoanut oil and peanut oil are better for the purpose. One well known method in preparing this product is to churn pure oleo-oil in unskimmed milk or even pure cream.

Refined cotton seed oil is used to pack sardines. The poorer grades of the oil are employed in the manufacture of soap, candles and phonograph records.

Great quantities of cotton seed oil are transported in tank cars.

Most of the mills are small and widely scattered. The crude oil is hauled in tank cars from the mills to the refiners. Tank cars also serve to carry the refined oil to the manufacturers of cotton seed oil products. Standard Tank Cars in this service are provided with steam coils.



CHAPTER XIX

Corn Oil

A Fine Edible Oil from Indian Corn

CORN OIL, formerly an unimportant by-product, has come into prominence in the last decade as another food oil. It exists in the small germ portion of the common Indian corn. Were it not for the fact that this germ is separated in the preparations of cornstarch and brewer's grits, and sometimes in the making of meal and other corn products, it probably would be unknown as a commercial commodity. For, although the germ is more than half oil, the oil proportion of the entire kernel is only from 3 to 6.5 per cent.

If the germs are left in the corn product, the oil soon becomes rancid and the product is made unfit for food. Therefore, hominy and cornmeal that are to be kept for any length of time, and cornstarch always, must be degerminated.

There are two methods of accomplishing this. The older, known as the wet method, is to soak the kernels in a dilute sulphureous acid. In this way the germs are toughened so that they won't become mangled when the corn is cracked up. Being lighter than the starchy portions of the corn,

they are separated in water. The second method is a mechanical one known as the automatic degerminator.

The oil is then extracted by processes similar to those used in securing cotton seed oil.

The wet process yields more oil but the effect of the acid is to make it rancid. The oil from the dry process is fit for table use with little or no refining.

Corn oil is now available in small retail packages as a table and cooking oil. Large quantities are used for technical purposes and for lard substitutes. It is also used for making cores in foundry work.

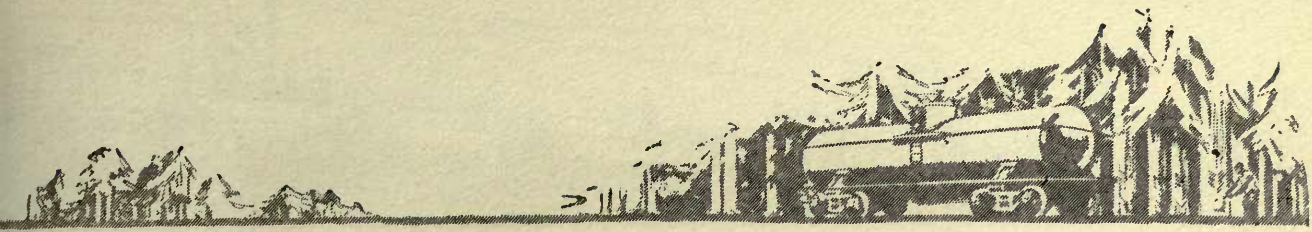
A clean Standard Tank Car is the most suitable transport for the oil.

A TYPICAL CORN FIELD IN NEBRASKA

From this familiar grain is produced one of the most popular of the edible oils—corn oil. The wide variety of the uses of the tank car is evidenced in its employment for shipping corn oil.

A FLAX FIELD IN WYOMING

This great crop from which we get linen, also produces linseed, the raw material from which linseed oil is prepared. The service of the tank car in transporting linseed oil is shown by the extensive use of the oil in paints and in printing and lithographic inks.



CHAPTER XX

Linseed Oil

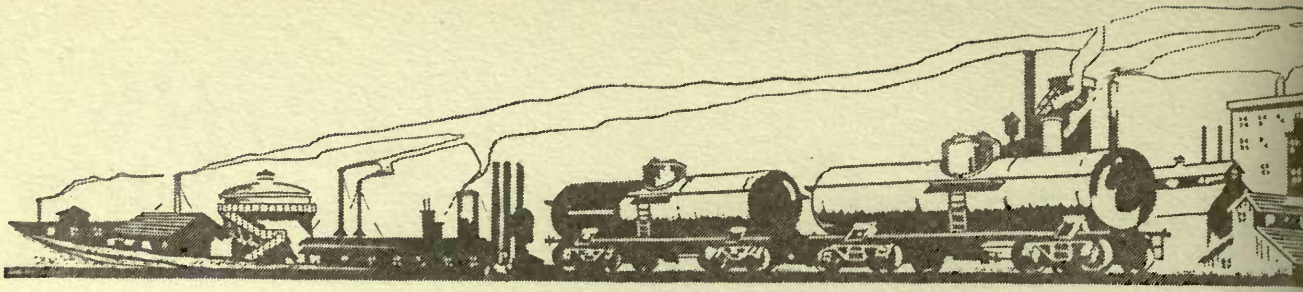
The Value of this Oil from Flax Seed in the Manufacture of Paint and in Other Industries

LINSEED OIL, like cotton seed oil, stands as a commentary on the bounties of nature. We get it almost as largess in the cultivation of flax for linen, just as we get cotton seed oil in the production of cotton. Thus two of nature's best materials for clothing mankind give also two of the most plentiful and valuable of oils.

The artist, the commercial painter, the printer and the lithographer all depend for their materials on linseed oil. It is the most valuable of the drying oils and finds its greatest use in the preparation of paints and varnishes. Also it is a principal ingredient in printing and lithographic inks.

Linseed can be grown in both tropical and temperate climates, but there is considerable difference in the seed of the two latitudes for oil purposes. In the tropics the seeds grow larger and contain a greater volume of oil, but the temperate climate seeds give a higher quality of oil.

The ancient Greeks and Romans used linseed as a food. The Abyssinians today, it is said, eat linseed roasted. In



certain parts of Poland and Hungary and in Russia, the oil is used to some extent as a food. An old remedy for wounds was a linseed poultice, but medical authorities today condemn the poultice on the ground that the linseed favors the growth of micro-organisms.

To manufacture the oil the linseed is ground into a fine meal. The oil is extracted by steel presses, with or without the aid of heat. If pressed without heat the product is a golden-yellow oil of the type that is used as an edible oil. When heated the oil is a deeper and darker color, and although it is secured in greater quantities, it must be put through a process of refining. If stored for a long time in tanks it purifies and has a high value as "tank oil." Time in this refining process is saved by a treatment with sulphuric acid, the acid charring and carrying down the bulk of impurities. The highest grade of oil, known as "artist's oil," is refined by exposure to sunlight in pans with glass covers.

The paint industry uses both crude and boiled linseed oil, the boiled oil being the base for most oil varnishes. The boiling is done in iron or copper boilers where, after a certain time, dryers are added. Among the dryers are lead acetate, manganese borate, manganese dioxide, zinc sulphate and other compounds.

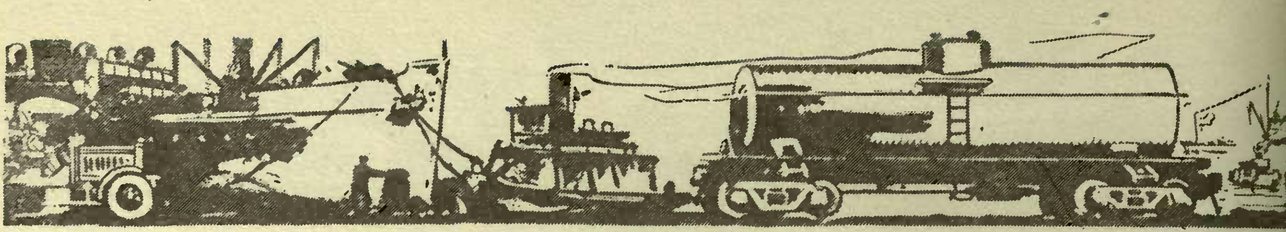
For the making of ink it is boiled down to the point when it is inflammable and then covered over and left until it becomes of such consistency that it may be drawn in threads.

The cake that is left of the meal, after the oil has been extracted, is used as cattle feed.

The oil is employed for water-proofing fabrics for raincoats and similar wearing materials.

Because of its high value linseed oil is subject to many falsifications. Often cheap seeds are put with the linseed before the oil is extracted. The oil may be adulterated with cotton seed oil, niggerseed and hempseed oil. These adulterations are difficult to detect, except in the applications of the oil, and dealers take many precautions to prevent them.

Tank cars for the shipment of linseed oil have unusually large domes, as the oil is loaded at high temperature. The tanks are coiled that the oil may again be heated to flow freely in unloading it.



CHAPTER XXI

Nut Oils

How Cocoanut and Peanut Oils Contribute to the World's Foods

IN supplying the world with foodstuffs, certain nuts are coming more and more into general use. Principal among these are the cocoanut and the peanut.

Cocoanut oil comes from the nuts of the cocoanut groves of the tropics. It is pressed from the white meat of the cocoanut and is not the milky liquid inside the nut. The American supply is imported largely from the Philippines, Java and Ceylon. It is consumed in butter and lard substitutes, in the manufacture of soap, and to some extent as a heavy lubricant.

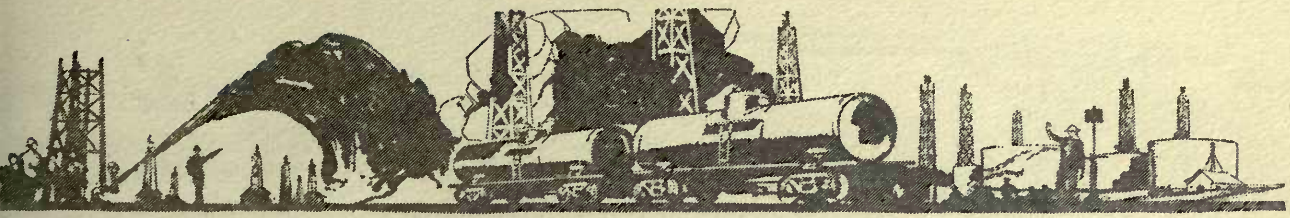
Impetus was given the growing of peanuts by the ravages of the boll weevil in the lower sections of the cotton belt. Technically, the peanut is known as the ground nut, as it grows in the ground on the root of a small vine. There are many varieties of peanuts, the best for oil production being the Spanish variety. The nut was grown by the aborigines of the Western World, it probably being a native of Brazil, and was introduced to Europe by early explorers.

THE WAY COCOANUTS GROW

Cocoanut oil is an important import. The oil expressed from the white meat of the cocoanut is employed in lard and butter substitutes and in soaps. The quantities consumed demand tank car transportation.

A SCENE ON A PEANUT PLANTATION

This negro laborer is stacking peanut vines. However, on big plantations, the crop is planted, cultivated and harvested with machinery. To produce the oil, big mills, somewhat like cotton seed oil mills, are required to grind up the nuts and extract the oil with presses. The tank car is then employed to transport large quantities of the oil to the various manufacturers of peanut oil products.

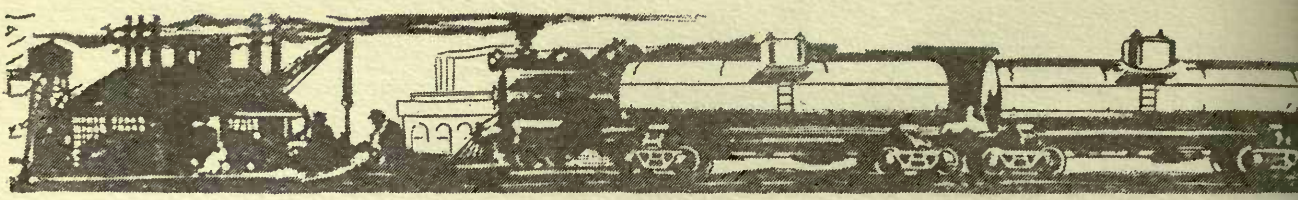


When the boll weevil pest had reduced the cotton crop in certain sections to the point where the local oil mills were without cotton seed as a raw material, it was found that peanuts were a good substitute crop, both for the farmer and the millman. Not only is the oil valuable, but the hay and press cake make highly desirable cattle feeds.

Many cotton oil mills have been adjusted to manufacture peanut oils, but the better qualities of the oil are produced by specially designed machinery. A partial pressing gives a clear nutty flavored oil that is suitable for table purposes without refining.

The best oil is secured from shelled peanuts but much of it is made by pressing shells and all.

It goes into butter and lard substitutes, and the cheaper qualities are used in the manufacture of soap.



CHAPTER XXII

Soya Bean Oil

A New Product for America that is Useful in Manufacturing Foodstuffs and as a Substitute for Linseed Oil

THERE is much similarity in the production of soya bean oil to the method employed for cotton seed and linseed oils. A distinction is that while the bean has been cultivated in Asia for 5,000 years, it is only within the last decade that it has become a crop of importance in the United States.

The vegetable oil business in general received a great impetus from the war. Prior to then the great bulk of this business was in linseed and cotton seed oils. The new demands brought great importations, and among them the greatest quantity was of soya bean oil from Manchuria. It is not an uncommon sight now to see whole trains of tank cars loaded with soya bean oil leaving Seattle, Washington, which is the chief port for oil imports.

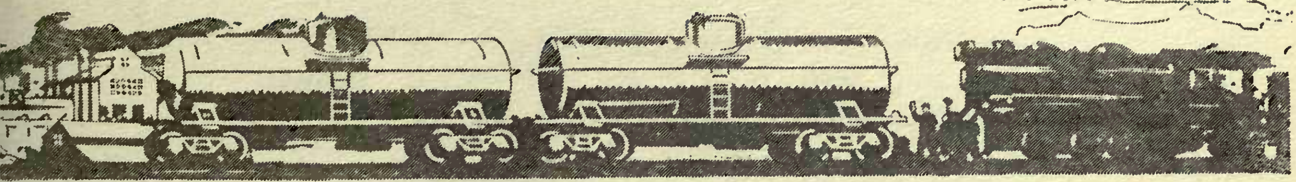
The bean has developed into a big crop in parts of the cotton and corn belts, for forage as well as for oil. It is easily grown in a large part of the United States, its general

AN OKLAHOMA SOYA BEAN FIELD

Soya beans is a new crop adapted to the United States from Manchuria. The oil expressed from the beans has practically the same uses as cotton-seed oil and also is suitable as a substitute for linseed oil. The vine makes a valuable forage.

LIQUID TRANSPORTATION IN ARABIA

These Bedouin women are shown in the service of their tribe which tank cars perform for more advanced peoples; they are carrying water in goat skins.



adaptations being about the same as corn. It has a large yield of seed and a fine quality of foliage, and is free from insect enemies and plant disease. The beans are largely used by Asiatic people for food, being very rich in protein. Owing to the strength of the meal, it has been found best to mix it with some less concentrated food before feeding to cattle or farm animals.

In the extraction of the oil, a cake is left which is ground into soya bean meal.

The oil is used by soap makers, by some oleomargarine manufacturers, sometimes for lubricating purposes, and recently it has been discovered to be a fair substitute for linseed oil in the manufacture of paint.

CHAPTER XXIII

Olive Oil

Its Long History and the Reasons for its Great Value

OLIVE OIL stands today as it has through the ages since the glory of Greece and the grandeur of Rome—one of the earth's luxuries. The olive branch won its place as the emblem of peace because of the value of the oil and the necessity, among ancient nations, of victory before the oil could be secured from the groves of people and conveyed to the seats of the mighty. The ancient Greek warriors anointed themselves with it after the bath, and a proverb of luxury and happiness among the Romans was, "wine within and oil without."

The fruit, too, was appreciated in ancient times, both ripe pickled olives and the green ones, steeped in brine. In the ruins of Pompeii, preserved olives have been found.

Around the Mediterranean coast the olive tree grows wild, but the value of its fruit and oil long since has resulted in an extensive cultivation of it. Italy holds first place in production, though from the time of the earliest settlers groves were planted in many South American countries, in

JERUSALEM AND THE MOUNT OF OLIVES

The age-old fame of olive oil is evidenced by its manufacture from th trees of the Mount of Olives in the days of the Bible. Scienti ts say there are trees in the Holy Land that have been bearing fruit since the Roman Empire.

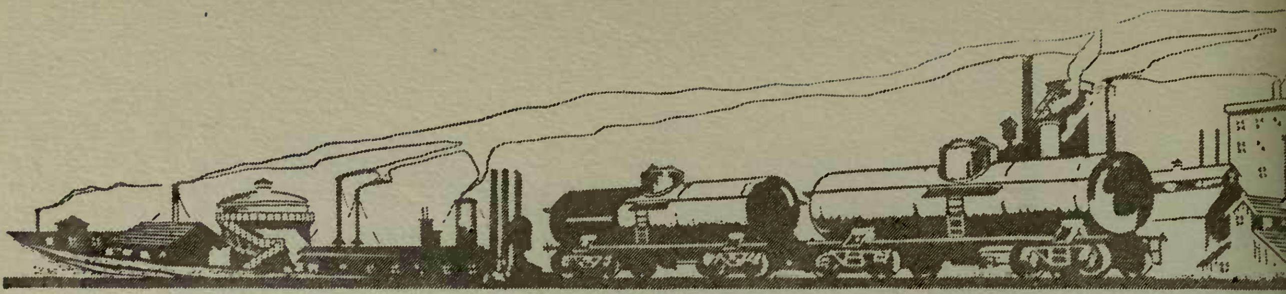
SUPPLYING LIQUIDS IN PALESTINE

Here again the onerous work of liquid transportation falls upon the women, earthen vessels being the receptacles employed.

California, Florida and other Southern States. However, the supply of both the fruit and the oil still is largely imported.

The wild trees are scraggy. The cultivated plants are among the longest lived of trees. It is claimed in Italy that some of the trees date back to the Roman Empire. The cultivated trees grow considerably larger than the wild ones, the trunks of the old trees attaining considerable diameter, but they rarely grow over thirty feet in height .

Olive oil is the most popular of the edible oils. It is employed in making fine soaps, articles of toilets, in butter substitutes, and for many other purposes.



CHAPTER XXIV

Whale Oil

Methods of Whale Fishing and Uses of the Oil; Other Fish Oils

WHALE OIL is obtained from the blubber, the fat beneath the skin of the whale, and, therefore, the industry begins with whale fishing.

Whale fishing has a history that dates back more than a thousand years. All modern maritime nations have had their whale fishing. It is probable that men first discovered the value of this great sea animal from stranded individuals. Just when they took to the sea for them is not known.

Oil is not the only valuable commodity taken from the whale; whalebone brings good returns, and sometimes ambergris, a most valuable substance for the manufacture of perfumes, is found in the sperm whale. The oil of the sperm whale, taken from its head, is the best of the whale oils. It varies in color from a bright honey-yellow to a dark brown. When refined it is an excellent lubricant for small and delicate machinery. In times past, the flesh of the whale has been thrown away to rot, but that isn't done any more. Parts of it are good as a food and the rest is ground up and used in fertilizers. The teeth are used as ivory.

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WHALES FOR OIL AND FOOD

Cutting up a whale on Long Island beach. Removing the blubber is like peeling an orange. The blubber, a thick layer of fat just beneath the skin, which prevents the natural heat of the body from being absorbed by cold water, has been used for nearly a thousand years for whale oil. Whale meat is an important food product in Japan and other countries, and recently the Government has encouraged its use in the United States.

WHERE WEST MEETS EAST AT THE GOLDEN GATE

East is East and West is West, just as Kipling says, but they meet in the ships at the Golden Gate—and tank cars are the connecting link with America's great and widely scattered industries. In return for petroleum products, we get from the Orient cargoes of vegetable oils.

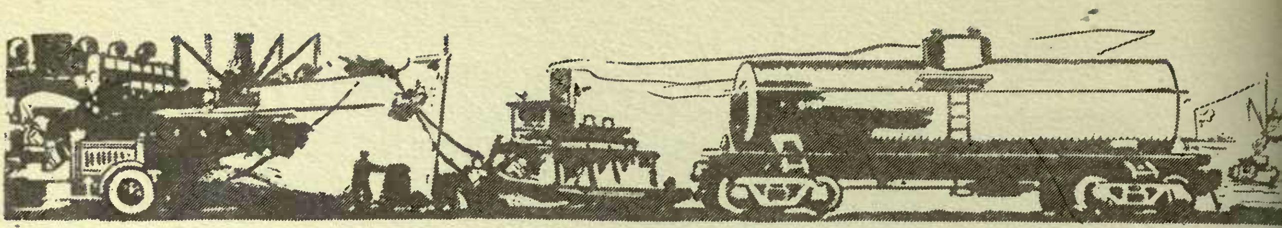
There are a number of varieties of whales and they inhabit many waters, from the warm waters of the south to the icy coasts of Greenland. The principal centers of the whaling industry in America are New Bedford, on the east coast, and San Francisco, on the west coast.

Around Greenland, the fishing still is done with the old-fashioned harpoon. When the whale is sighted it is shot with a harpoon from a cannon. The harpoon is attached to the boat with a strong rope. Then small harpoons are hurled into the whale by hand.

Where the industry is more developed, the harpoon has an explosive cap with a time fuse in its head, and the explosion takes place inside the whale. The ships employed vary from small sailing craft to steamboats. Usually the whale is towed to land before it is cut up for its valuable parts.

The fat is cut out and the oil then expressed and refined. But no matter how the oil is handled, it always retains an unpleasant fishy smell. It is very difficult to get the smell out of tank cars, once they have been filled with the oil, and prevent them contaminating other liquids that might be transported. The best plan is to use the cars exclusively in the fish oil trade.

Fish oil proper is less valuable than whale oil and sometimes is used to adulterate it. Its principal source is the menhaden fish, a small fish that appears in great schools along the northeastern coast of America, and is caught in quantities for its oil and the use of the meat in fertilizers. Menhaden oil also is used to adulterate linseed oil or as a



substitute for it. To extract the oil, the whole fish is boiled in water and the oil then is pressed out.

Other minor sources of fish oils are cod-liver, shark-liver, porpoise and blackfish blubber.

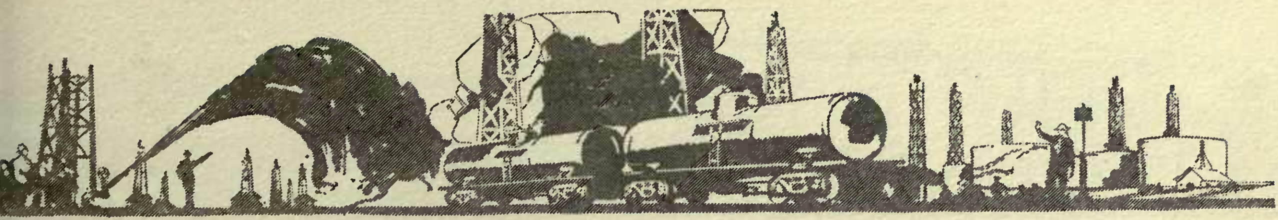
The uses of the whale and fish oils are in oiling wool for combing, in batching flax and other vegetable fibres, in currying and chamois leather making, and as a lubricant for machinery.

PREPARING GOAT SKINS FOR WATER TRANSPORTATION

The importance of liquid transportation all over the earth is evidenced by this extensive effort to supply vessels for carrying water in the Holy Land.

MAKING SOAP

This illustration, and two succeeding ones, picture three stages in the manufacture of soap. The men are mixing alkalies, fats and oils—ingredients of soap.



CHAPTER XXV

Soap

The Use of Fats, Oils and Alkalies in Making Soap; Different Kinds of Soap

IT is evident to one who has scanned these pages that the uses of various commodities handled in tank cars overlap. The story of an oil or an acid is not a distinct thing that stands separate and apart. The functions usually are performed in conjunction with some other liquid, also handled in tank cars. The most striking illustration of this perhaps is in the manufacture of soap. The principal raw materials required for soap are fats; but these fats may be from animal matter or vegetable oils, embracing the range of most animal and vegetable oils handled in tank cars, as follows:

Oils from the by-product fats of packing houses, castor oil, cotton seed oil, corn oil, linseed oil, peanut and cocoanut oils, soya bean oil and olive oil.

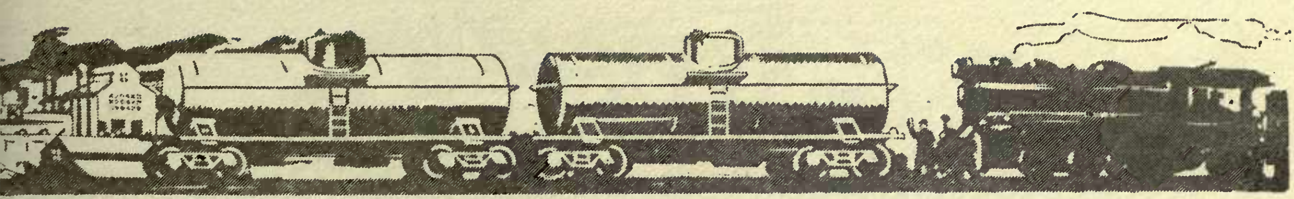
In addition, tank cars handle caustic soda and caustic potash, glycerin, rosin and silicate of soda as contributions to soap making.

You must go far back in history to find the origin of soap, but the memory of living Americans antedates its present intensive and extensive use. We know this by a comparison of the bathrooms of a modern home with the toilet devices of an ante-bellum mansion, to say nothing of historic European castles. Yet the soap industry is far bigger than the supplying of toilet articles to individuals. Soaps are important in textile manufacturing and for sanitation.

The Bible mentions soap, though it is now considered that the references were to the ashes of plants and similar purifying agents. According to Pliny, the Germans invented it, primarily to give a brighter hue to the hair. The Romans got it from them, and its use continued on down through the centuries. But the chemistry of its making was unknown until the early nineteenth century, due to discoveries by Chevreul, a Frenchman, and with that a new impetus was given to the business.

The manufacture of soap is the result of interaction of fatty oils and fats with alkalies. It first was made from goat tallow and beech ash, and for a long time it was thought that the product was merely a physical compound of a fat and an alkali. Chevreul's discovery was of the chemical action that takes place, thus forming an entirely new matter. Fatty oils and fats are composed of glycerin and fatty acids. Treated with an alkali, usually under heat, the acid combines with the alkali, forming soap.

Fats for soap come from abattoirs and packing houses, one of the chief sources being from ground bones.



Caustic soda and potash are the alkalies most generally used, and they are largely secured direct from alkali manufacturers.

But the manufacture of soap does not end so simply. It must have other ingredients and considerable treatment before it is fit for commercial use. The various kinds depend upon the raw materials used and the methods of manufacture.

The hard yellow and primrose soaps are made from beef and sheep tallow, with rosin added. Cheaper mottled and brown soaps have for their base bone fat. Lard oil is applied to hard toilet soaps. Dyers of silk and cotton fabrics use soaps from vegetable oils, while fuller's fat is the material from which soft soap comes.

Usually mixed oils are used. Cocoanut and castor oil will react on the alkali and make a soap without heating. Castor oil will yield a transparent soap. Cocoanut oil is used for certain hair washes. Either, however, is better employed when combined with cotton seed oil, fat oil or some other oil. Crude palm oil, with bone fat, produces a brown soap. The curd soaps are made by boiling the fat with alkali and removing the excess alkali. In using olive oil, in this method, the French originated Castile soap. Palm oil is a favorite for soap in England. We have a famous toilet soap in this country produced from a combination of palm and olive oils.

Ordinary soap, you know, is of no service with salt water. That is because it is insoluble in salt water, its precipitation

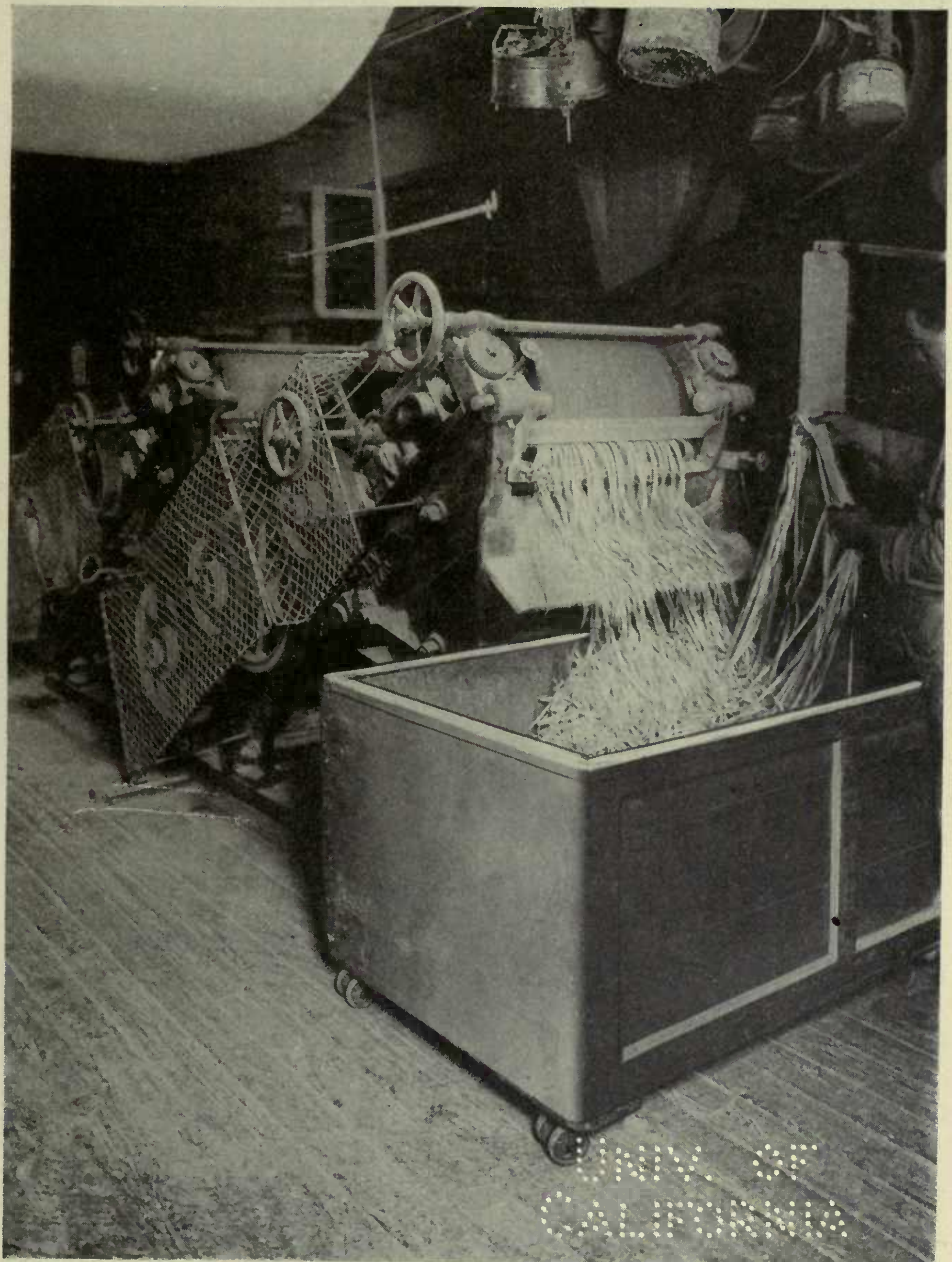
in its process of manufacture having been caused by the addition of common salt. Certain soaps are soluble in brine, and for this reason they are known as marine soaps. Cocoanut oil soap is typical of marine soaps.

The odor of soaps may be regulated by the addition of perfumes to the soapy mass. It is desirable that the goods contain a large proportion of water and yet remain solid and firm. This is aided by the addition of a strong solution of silicate of soda, which also adds something to the cleansing power of the soap.

Soap can be cut out or moulded in any size or shape, according to the wishes of the manufacturer. It can be made to float by aeration, that is, mixing air with the hot liquid soap. Transparent soap is made by dissolving ordinary soap in alcohol and then distilling off most of the alcohol.

Some of the most popular soaps are glycerin soaps. They are obtained by the addition of glycerin to pure hard soap. The soap is melted and the glycerin poured in and stirred. When the compound is poured into forms and cooled, it forms a transparent mass. An excess of glycerin makes a fluid soap. A small proportion produces a tenacious lather, a trick that many a child has been taught when blowing soap bubbles. This quality makes glycerin valuable in shaving soaps.

Authorities are not wholly agreed as to the causes of the cleansing power of soap. The most generally accepted theory is that of its emulsifying power on oil and its property



HANDLING CRUDE SOAP

A more advanced step in its manufacture. The grinding process preparatory to molding into cakes.

PRODUCING THE BATH-ROOM ARTICLE

The last step in soap manufacture consists of molding and stamping. The small machine in the background accomplishes the feat of transforming small cylinders of soap into oval cakes, each as alike as peas in a pod.

of penetrating oily fabrics and lubricating impurities so that they can be washed away.

Fats are loaded in tank cars and unloaded out of them in a liquid state. The tanks are coiled, for although the fats congeal in transit, the mass can be melted and easily unloaded.

Liquid soap is also shipped in tank cars.

CHAPTER XXVI

Lard

A Great Food Product from Hogs

LARD is made from hog fat. Neutral or leaf lard is secured from the leafy fat around the bowels and kidneys. A poorer quality is made from back fats. The neutral lard is used in great quantities in the manufacture of oleomargarine. The back fat lard is employed in cooking.

Lard manufacture is conducted on a huge scale by the big packing houses. The fat is taken from freshly killed hogs and hung up in refrigerators, to remove as soon as possible the animal heat. It is then cut into small bits, or pulverized by machines, and boiled. After the boiling, the fibre substance is precipitated by the addition of salt, and it gradually settles. The pure lard is then syphoned off.

Neutral lard frequently is adulterated, compound lard even being made without any of it, as described under "Cotton Seed Oil." The best compounds, however, contain some hog lard. Favorite adulterants are beef and mutton stearine.

In the manufacture of oleomargarine, it is combined with oleo-oil, some vegetable oil, milk, salt and coloring. Some-

Photograph from U. S. Department of Agriculture.

FILLING TUBS WITH PURE LARD

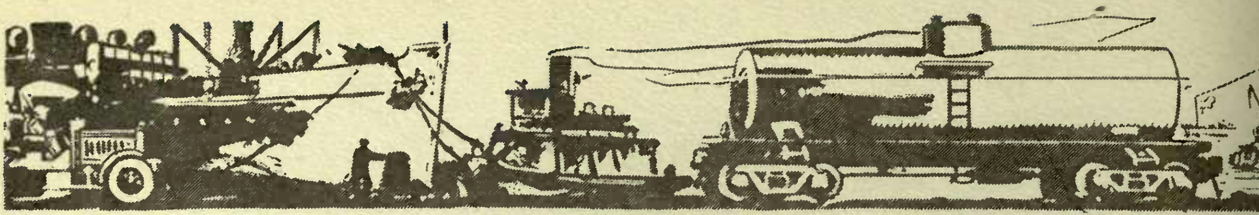
Vital to the subsistence of human beings are fats, and the most important of these is lard from hogs. Fats are reduced to a liquid grease by steam heat and then drawn into tubs, as shown above in the photograph from the Department of Agriculture.

A COLORADO HOG FARM

On the first of January, 1919, the value of livestock on our farms was $6,100,000,000. Swine make up more than one-fourth of this amount—$1,665,987,000.

times a portion of real butter is added. The mixture is handled through several heating and cooling processes and finally churned into oleomargarine.

In color, lard is white and of a butter-like consistency. It easily is reduced to a liquid state by heat. To be loaded in tank cars it must be in a liquid state, and the cars are equipped with steam coils so that the lard can be heated to be unloaded.



CHAPTER XXVII

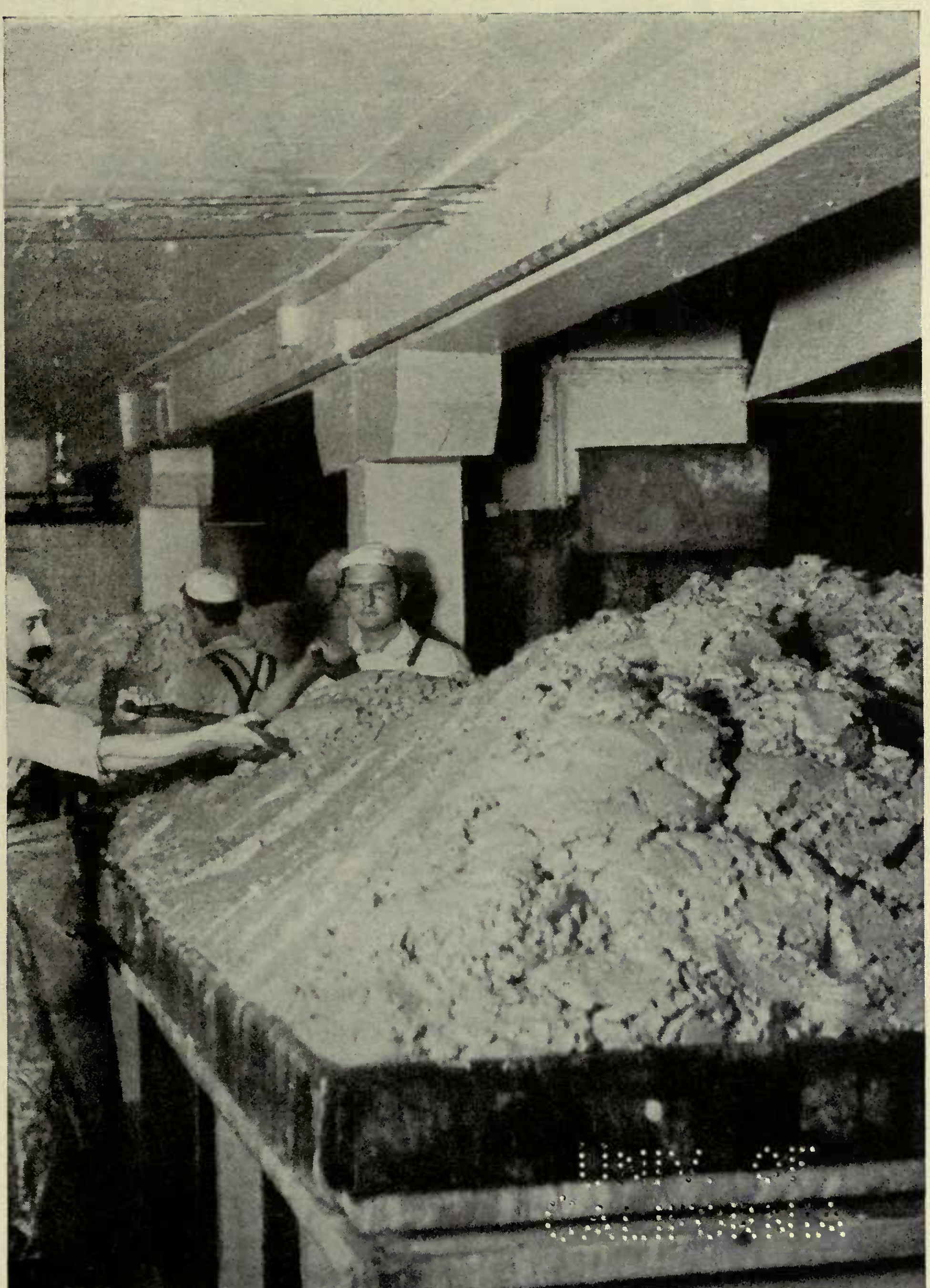
Lard Oil

A Valuable Oil Expressed from Lard

LARD OIL is expressed from lard by slight heat and hydraulic pressure. It is a clear and colorless liquid and is suitable for burning oil and for lubrication. It is applied in the finishing processes in manufacturing silk and cotton goods.

The expression of lard oil leaves lard stearine. The best qualities of stearine are consumed in oleomargarine and the cheaper products are used in making candles and soap.

The tank cars used to carry lard oil need not be coiled but they must be thoroughly clean.

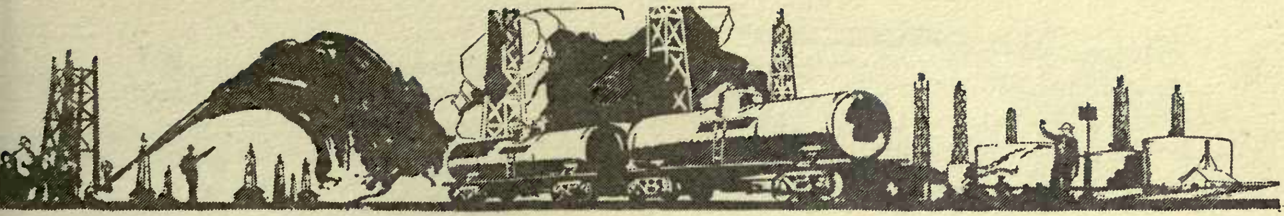


LARD FOR LARD OIL

Lard oil is expressed from lard and is used as a burning and lubrication oil and in the manufacture of silk and cotton goods.

TURNING BY-PRODUCTS FROM WASTE INTO WEALTH

Looming among the first of American enterprises is the packing industry—a business made national and international through its capacity to utilize by-products. Through its broad sense of economy, it has made the tank car its agent in the transportation of oils and fats for the making of soaps, compound foods and numerous other highly useful products.



CHAPTER XXVIII

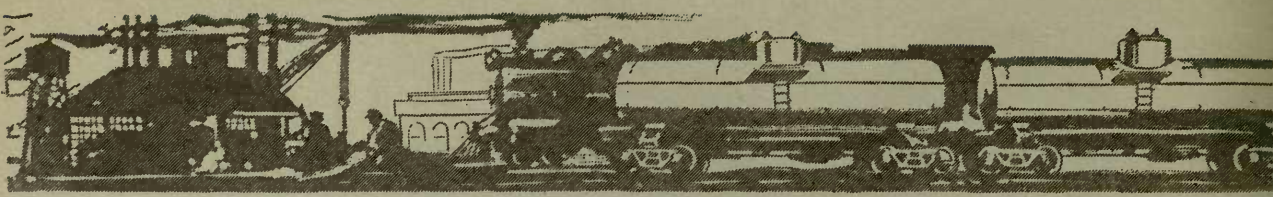
Glycerin

The Source of Glycerin and its Application in Medicine and Manufacturing

GLYCERIN is a viscid, colorless liquid, one of the very valuable components of fats. It is obtained by the action of alkalies on fats, most fatty substances possessing it. It can not be distilled by itself without decomposition, but is readily volatilized in a current of superheated steam. It is produced, to a small extent, as a by-product of packing houses but is secured more largely from the spent lyes of soap manufacturers.

Glycerin has many valuable qualities. It will act as a solvent on many coloring fluids that will not dissolve in water alone. It is an antiseptic as well as a solvent. It is a fine lubricant for clockwork, watches and so forth, and is employed for a number of purposes in the arts. It does not evaporate nor turn rancid, which, together with its excellent solvent power for iodine and similar drugs, gives it a wide use in medicine. Mixed with salicylic acid, it is employed to preserve eggs. Its most commonly known use, perhaps, is in the composition of nitroglycerin, yet this is only one of an extensive number of chemical products in which it is employed.

Much of this country's supply is imported. Its shipment is very carefully done because of its high value. Most of it is shipped in drums to the refiners and then put up in bottles and other small containers.



CHAPTER XXIX

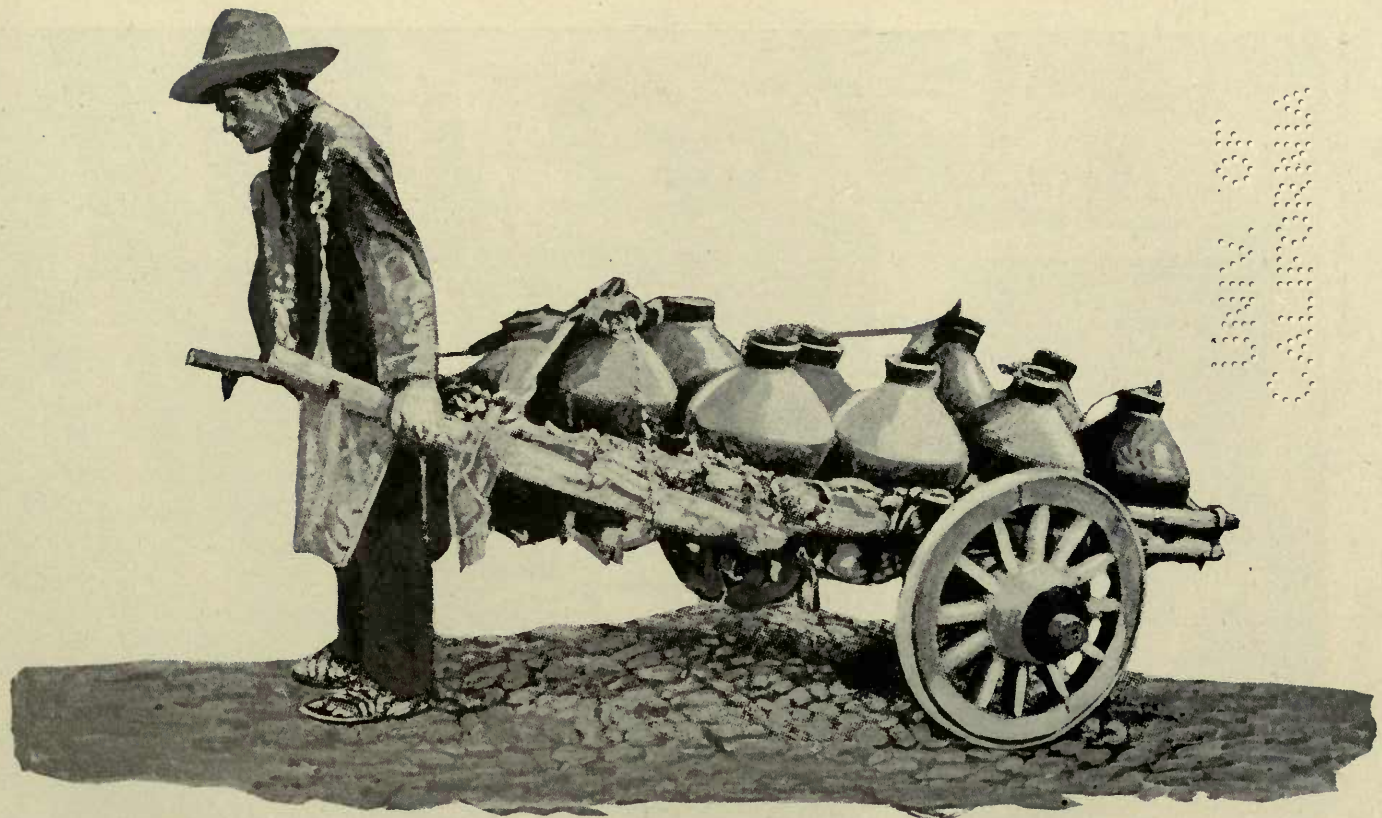
Silicate of Soda

Its Use in Soap and for Preserving Eggs

SILICATE OF SODA is a chemical salt, having as its base silica and the metal sodium. It is important in nature as the commonest material for the forming of rock and other minerals. Also it is the greatest source of sodium, which has an extensive use in organic chemistry. The compound is valuable in the manufacture of soap, but its part in this industry has been noted under "Soap."

Silicate of soda is the chief component of many egg preservers that have a ready sale with housewives. A simple illustration of its use is as follows: Immerse the eggs in a solution of water and silicate of soda for about three minutes. Have a rack prepared on which to stand the eggs on end. The air causes an interaction between the lime in the egg shells and the silicate of soda that forms a glassy and airtight sheet around each egg. The eggs then may be shipped or kept for months without spoiling. This use causes silicate of soda to be popularly known as "water glass."

Silicate of soda is widely scattered over the earth's surface in the form of rock crust. When shipped in tank cars it is in solution in water.



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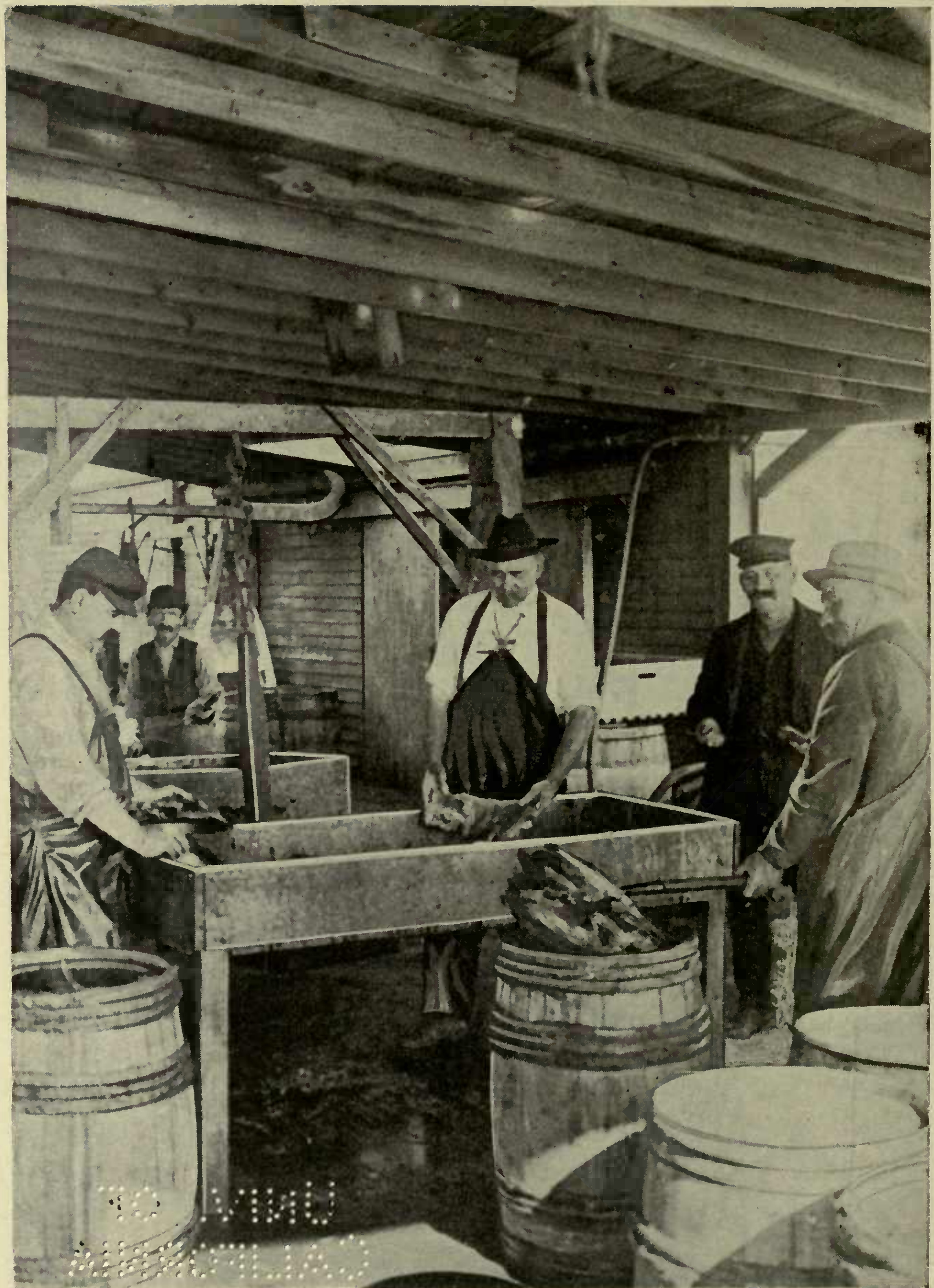
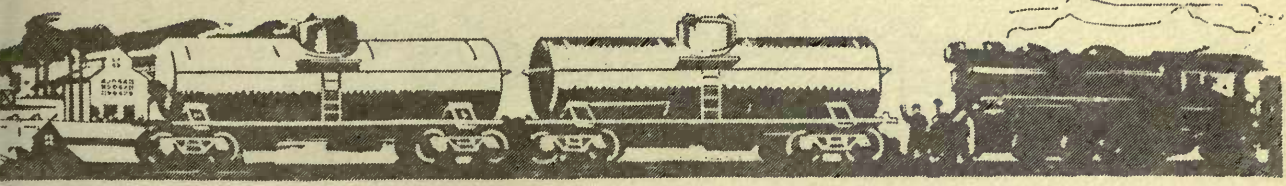
A PRIMITIVE METHOD OF TRANSPORTING OIL

In parts of the world out of touch with industrial progress, oil even today is transported in earthen and leather vessels.



PACKING SALT FISH

Tank cars aid this industry by supplying calcium chloride brine in which the fish are preserved.



CHAPTER XXX

Calcium Chloride Brine

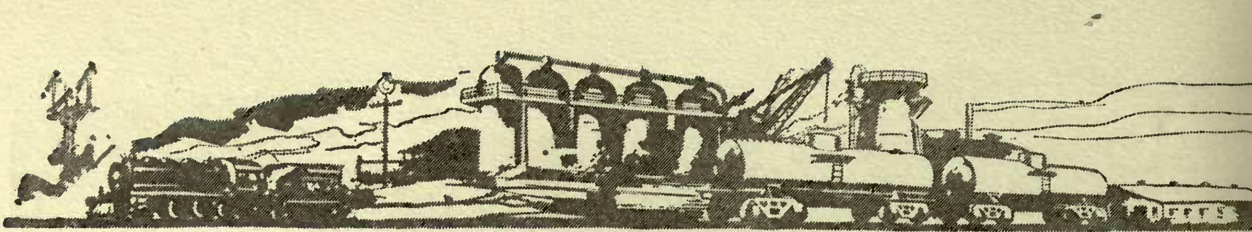
A Salt Solution Used in Preserving Fish, Meats and Vegetables

CALCIUM CHLORIDE BRINE is the salt, calcium chloride, in solution in water. Calcium chloride is found in many natural waters and is a by-product of the manufacture of carbonic acid and of potassium chlorate.

It is a source of both the metal calcium and the gas chlorine. The salt is very soluble in water and therefore is handled readily as a brine.

It is employed as a desiccating agent in preserving fish and meats and all sorts of vegetable and animal matter. In dissolving rapidly in water the salt absorbs considerable heat. This property makes it useful in forming freezing mixtures, on the principle of refrigeration.

Calcium chloride brine is easily shipped in Standard Tank Cars.



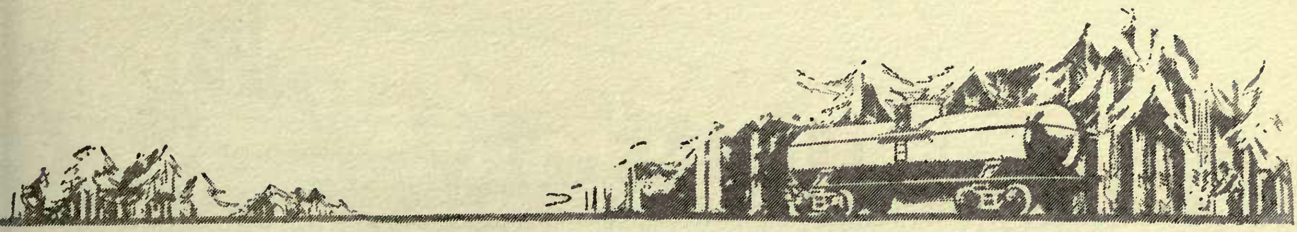
CHAPTER XXXI

Oxalic Acid

An Acid Used in Dyeing and Printing Textiles

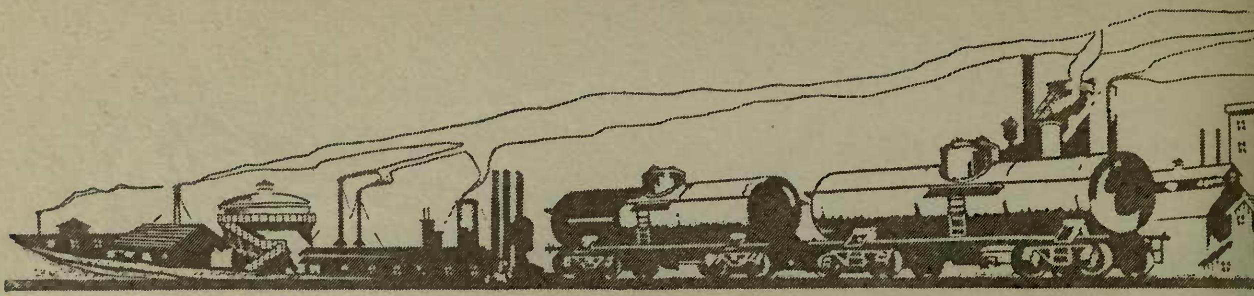
OXALIC ACID is another illustration of the vast possibilities of chemistry. In reality it is an acid of oxygen, oxygen being its chief element. It is used in the dyeing and printing of wool and other textiles, to bleach straw and to remove rust stains from glycerin and stearine and to polish brass. A number of its salts—potassium oxalate, sodium oxalate and ammonia oxalate—are produced for use as a substitute for the acid. Potassium ferrous oxalate is a good photographic developer.

It is one of the oldest known acids and is found in many plants, especially wood-sorrel, as acid potassium salt. By the oxidation of sugar, starch, cellulose and similar compounds with nitric acid, it may be formed, but its manufacture is largely performed by fusing oxygen-holding compounds with caustic soda and caustic potash. The best material for the latter process is the sawdust of soft wood. A stiff paste is made with the caustic alkalies and it is heated in flat iron pans. A little warm water is added to remove the excess alkali, and the mass is then boiled with slaked



lime, forming insoluble calcium oxalate. This compound is in turn decomposed, and the oxalic acid produced by a treatment with sulphuric acid.

The acid crystallizes and looks very much like Epsom salts, but it is very poisonous and has resulted fatally when taken by mistake. The crystals effloresce in the air and are readily soluble in water. Its tank car shipments are in solution in water.



CHAPTER XXXII

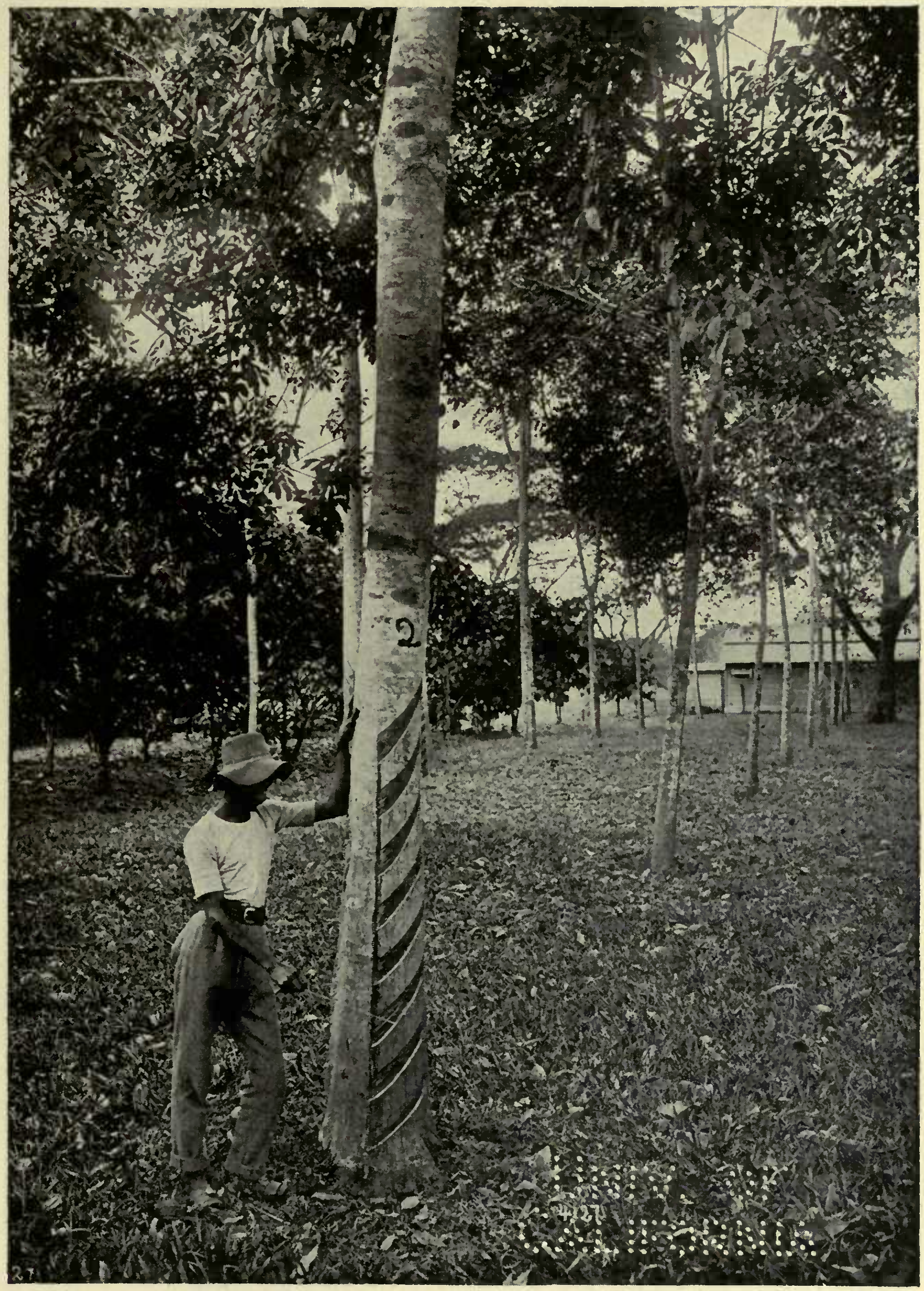
Carbon Bisulphide

An Important Industrial Solvent

CARBON BISULPHIDE is a clear, pleasant smelling liquid that is very volatile, and gives off an inflammable vapor. It is insoluble in water, but easily dissolves in alcohol, benzol or ether and various oils. In turn it is a solvent for sulphur, phosphorus, wax, iodine and many substances. Its reactions may be extensively employed in organic chemistry. Industrially, it is used as a solvent for caoutchouc, the gum of India rubber and of similar tropical trees, for the extraction of essential oils, as a germicide, and as an insecticide.

It can be conveniently prepared, because of the abundance in nature of the elements which form it, in carbon compounds, sulphur and pyrites—sulphur ores. The heating of charcoal and pyrites gives off a vapor that is condensed into the liquid. It can be made easier by passing sulphur fumes over red hot charcoal, the gas formed being condensed into the liquid.

However, the liquid produced by both these simple methods is very impure and has an offensive smell. It may

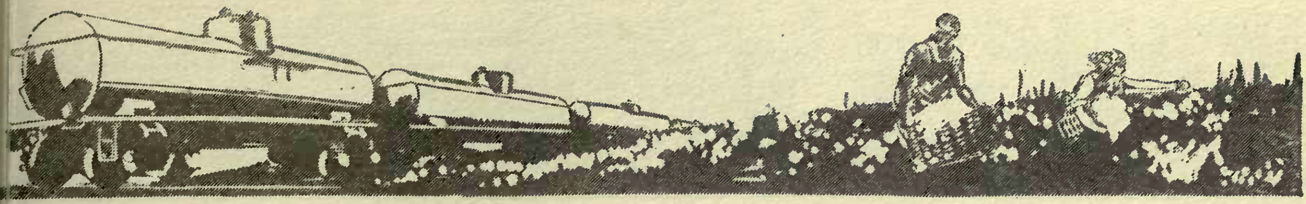


BLEEDING A RUBBER TREE IN SOUTH AMERICA

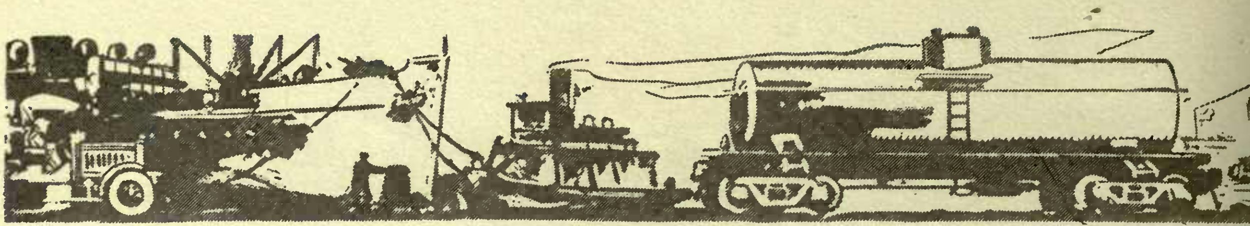
The manufacture of rubber into tires and an infinite variety of articles is one of the great outstanding industries of the world. In the preparation of rubber, tank cars handle carbon bisulphide, a solvent for the gum of rubber trees.

HOW A TRANSPORTATION PROBLEM WAS MET IN EAST AFRICA

Liquid and solid freight being moved by women in chains.



be purified by a thorough washing with lime water, the lime water being sprayed through the liquid until it escapes perfectly clear. The washed liquid is then mixed with a colorless oil and distilled at a low temperature. There are two intermediate steps in preparing it with charcoal and sulphur. The uncondensed gas is passed through a tower where there is a flowing vegetable oil that absorbs any carbon bisulphide oil, and then into a second tower containing lime, which absorbs any sulphureted hydrogen.



CHAPTER XXXIII

Zinc Chloride

Another Useful Solvent

ZINC CHLORIDE is produced by heating zinc in chloride gas, or by the action of hydrochloric acid on the metal. In the first instance, it distills as a white translucent mass which dissolves in a fraction of its weight in cold water. The product of the second method can not be evaporated to dryness without considerable difficulty.

In organic chemistry, it is used as a condensing agent. It will convert starch cellulose and many other organic bodies into soluble compounds. Its compounds are used in dentistry, surgery, and in the manufacture of paint and high grade cement.

Dissolved in water, zinc chloride forms a syrupy solution.

CHAPTER XXXIV

Arsenic Solution

Employed to Kill Weeds on Railroad Roadbeds

ARSENIC, a steel-gray, brittle and volatile substance, is well known through its employment in drugs. It is a chemical element classified as a metalloid, since it has qualities of both the metals and the non-metals. It is found in nature in combinations with sulphur, as a sulphide. The production of arsenic and arsenic compounds is through complicated chemical processes, but a point of interest to anyone about certain of the compounds is their quality of spontaneous inflammability in air at ordinary temperature.

Arsenic is highly poisonous, but it is combined with other chemicals so that its curative powers are preserved and its toxic attribute minimized. It has a wide use in medicine, one in particular being in the treatment of syphilis.

The tank car is used to handle an arsenic solution to kill weeds and vegetable growths along railroad beds and roads.

CHAPTER XXXV

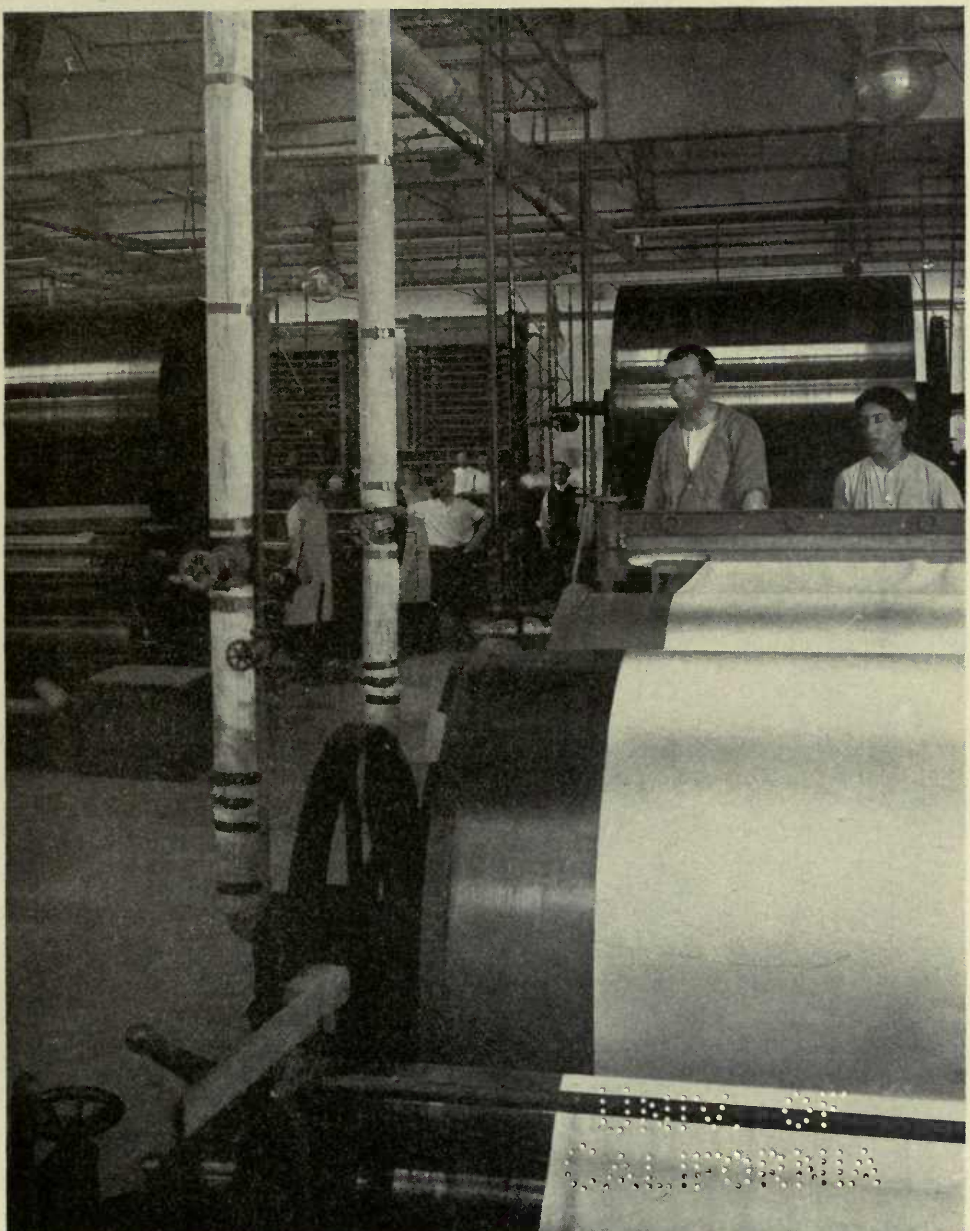
Lactic Acid

An Agent in Dyeing, and in the Chrome Process of Tanning Leather

COMMERCIAL lactic acid is obtained from milk from which the butter has been removed. There are many ways of producing it, since it is a result of a process of fermentation, certain bacteria acting on the sugar to form it. In making it from milk, the whey is put in wooden vessels and a process of fermentation allowed to take place, either by its own volition or by the addition of putrefied cheese. Powdered chalk is added to neutralize the acid, and the fermentation is continued for from ten to twelve days. Calcium lactate is thus formed and then decomposed by diluted sulphuric acid.

The calcium sulphate produced by the action of the sulphuric acid is removed by a filter press, leaving lactic acid. The acid is dissolved in water to a concentration of about fifty per cent for commercial use.

Wool and silk which are to be dyed with fast colors are treated with it. It is employed in the chrome process of leather tanning, its property in this industry being to hold the calcium salts in solution and prevent the formation of harmful deposits. In medicine it is employed for soluble lactates. In appearance it is a yellowish-brown liquid.

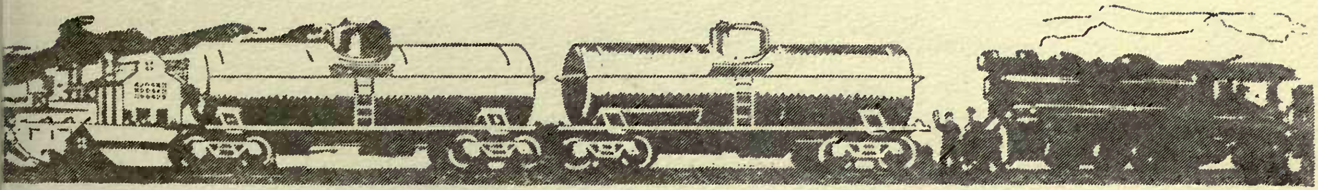


DYEING SILK

Modern dyeing requires highly refined chemical processes. Cows' milk is drawn on for one element, lactic acid—to treat wool and silk that are to be dyed.

GATHERING SUGAR-CANE IN CUBA

Much of America's sugar comes from Cuba. It is refined largely in the United States, and a principal by-product is molasses. The distribution of molasses among many large industries is accomplished with tank cars.



CHAPTER XXXVI

Molasses

How it is Made as a By-Product of Sugar Refining

MOLASSES, like commercial sugar, has two great natural sources — sugar-cane and the sugar beet. Much of it also comes from the sorghum plant, which, because of the quantities of gums and dextrin it contains, is unsuitable for sugar. This is the cane that is grown in the more temperate climates, much of it being ground up for stock feed. Quantities of molasses are produced as a by-product of sugar refining, both from sugar-cane and sugar beets.

The real sugar-cane requires a hot and moist climate. The principal area for its cultivation in America is in Louisiana. The larger quantities of the crude sugar for the refineries is imported from warmer climates.

Sugar beets are more adaptable to the temperate climates. America has a considerable production, but in Europe, especially Germany and France, they are a great crop.

The manufacture of molasses includes the whole process of sugar refining. In the case of sorghum, the cane is

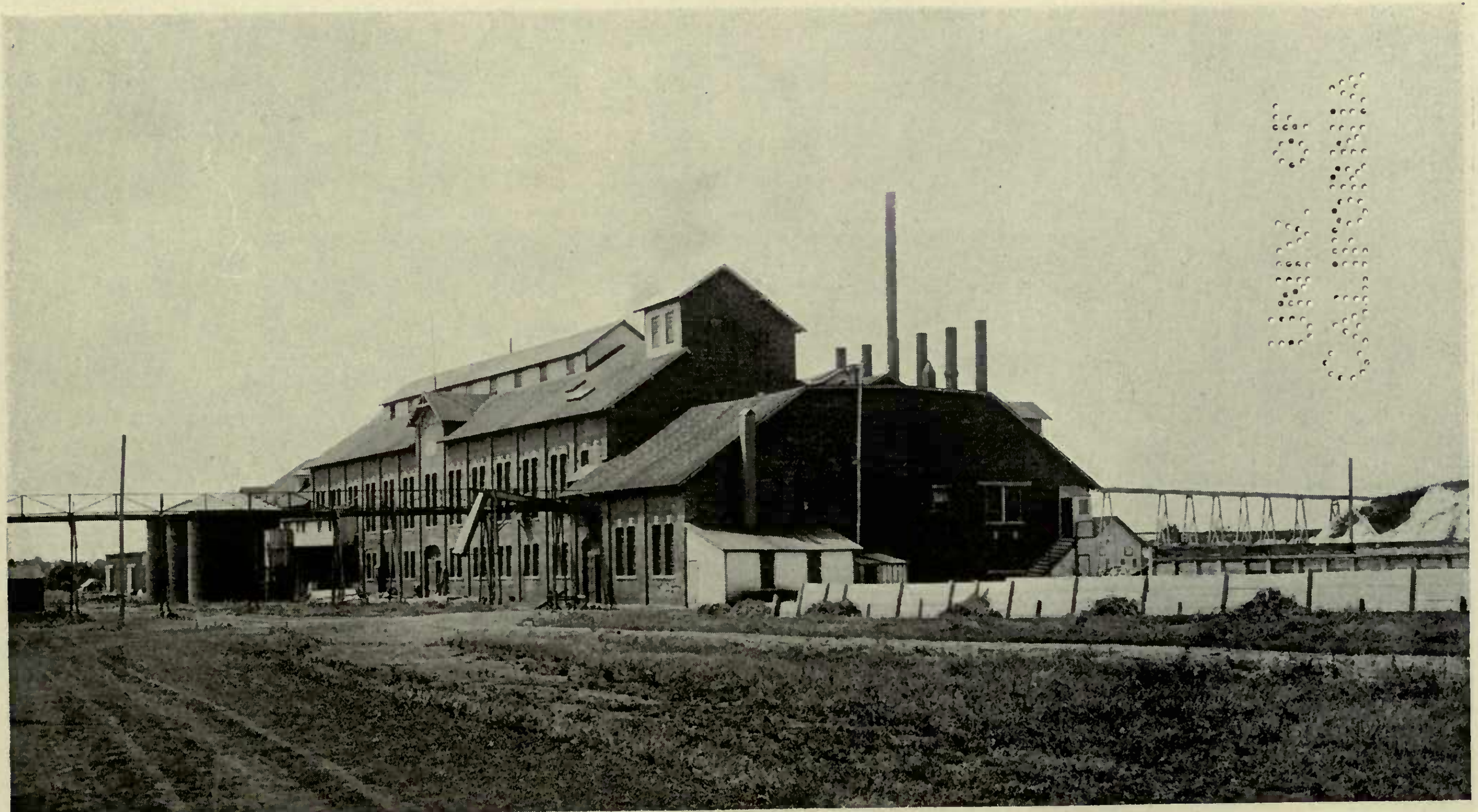
stripped of its leaves and seed and ground in mills that express the juice.

The syrup is then cooked in large pans in the open and impurities rise to the top as a scum and are removed. It must not be cooked too long, else the sugar will begin to crystallize. After the cooking, the molasses that it forms is stored for market.

In the preparation of sugar the juice is expressed from sugar-cane in much the same way. It is then strained through wire screens to remove bits of cane and other foreign bodies. The juice contains acids and other parts that are susceptible to rapid fermentation and must be immediately removed by defecation, which is a treatment with milk of lime. The lime, aided by heat, coagulates the albumen, and the gummy and other undesirable matters which rise to the surface as a scum are taken off. The juice is then run through a filter press.

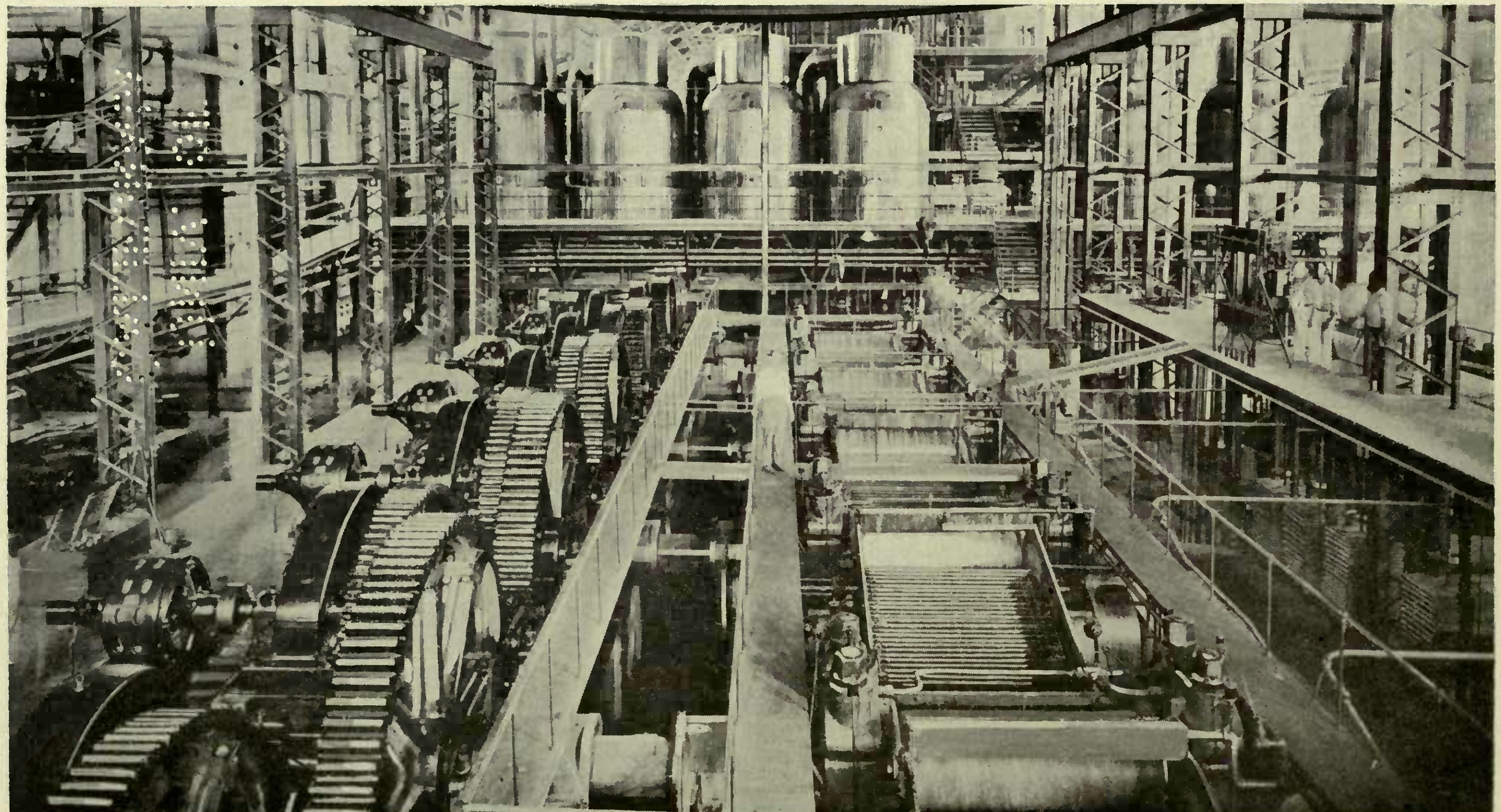
Evaporation is then undertaken, which essentially, is boiling down the syrup until the sugar begins to crystallize. An old method of separating the molasses from the sugar was simply to store the syrup in hogsheads and allow the molasses to drip out through holes in the end. This was very crude and has been made obsolete by the introduction of centrifugal machines.

The products of the first cycle are known as "first sugar" and "first molasses." The "first molasses" is put through a process like that of the original syrup and "second sugar" is obtained.



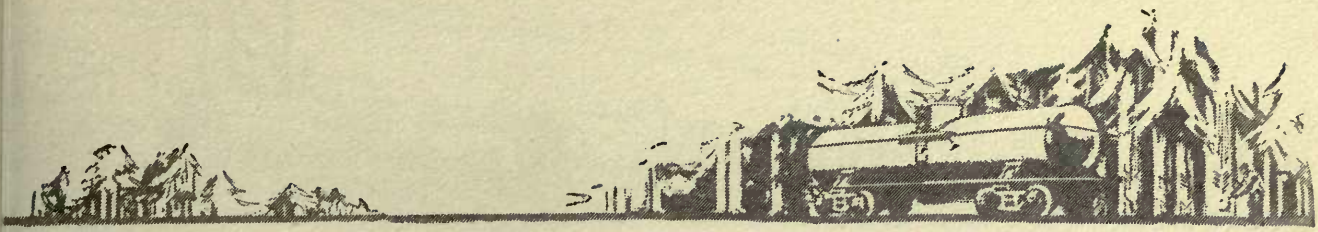
AMERICA'S FIRST BEET SUGAR REFINERY

This factory was built at Grand Island, Nebraska. Molasses also is a by-product of beet sugar, demanding tank cars in this industry.



A MODERN SUGAR-CANE MILL

This illustration shows an 18-roll, double-crusher, electrically driven mill on a big Cuban sugar plantation.



The molasses left contains about forty per cent of sugar. It is used to ferment rum or alcohol, and much of it is consumed in the preparation of cattle feeds. It has been used as a fuel.

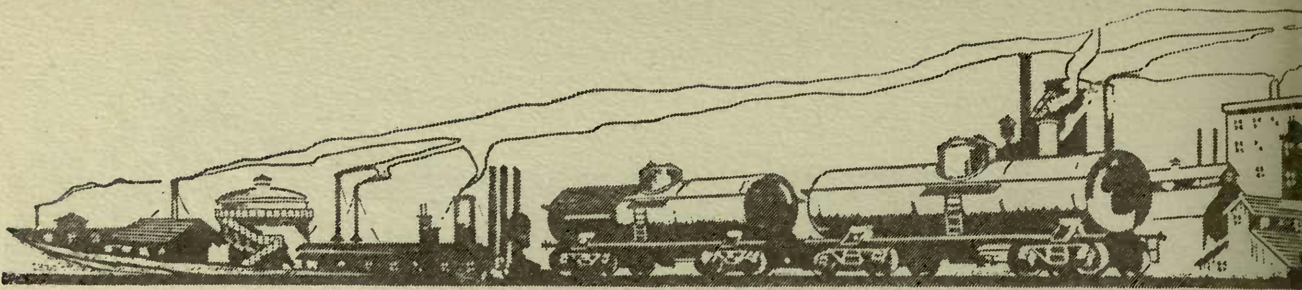
The "first molasses" may be used as a table syrup, but the "second" is unsuitable.

Beet sugar manufacture begins with washing the beets in water to remove the earth and foreign matters, and then cutting them into thin slices by a machine containing revolving knives. The chips are soaked in water, in heated tanks, and the juices containing the sugar thus dissolved. Another way is to grind the beets to a pulp and extract the juices by hydraulic presses. Centrifugal machines also are used, with beet pulp as the raw material.

The defecation and evaporation of the syrup is the same as already described.

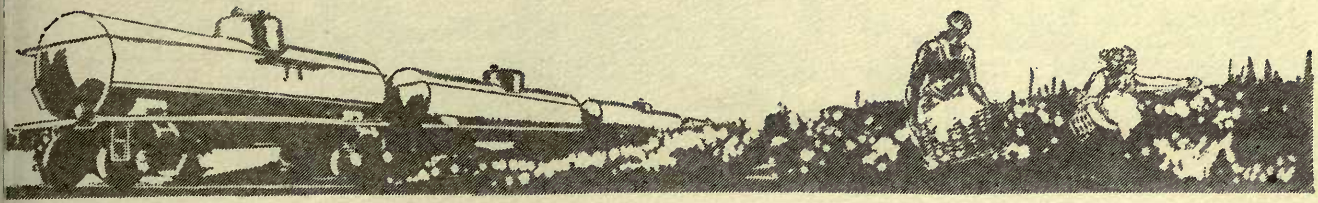
Beet sugar molasses is not employed to make rum and alcohol. Its greatest value is in the preparation of cattle feeds.

The sugar we have from both materials is still unfit for market. It must be refined. In principle, the process is as simple as that for obtaining the raw sugar, but it must be much more carefully and delicately applied. The sugar is put through various washings, solutions, filtrations and evaporations with water. The waters used absorb much sugar and are treated over again. Finally pure white sugar and an edible syrup are obtained. The sugar is granulated



by being heated in revolving cylinders. The heat dries it thoroughly and the revolutions of the cylinder prevent the grains from sticking together.

Molasses is a very heavy commodity and tends to congeal from cold. It requires a thoroughly coiled car with a gate valve at the bottom of the outlet leg. During warm weather, tank cars are successfully used without coils, and with only a four-inch outlet leg.



CHAPTER XXXVII

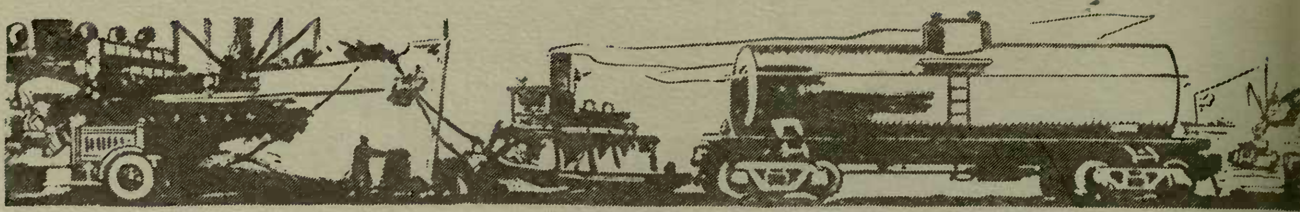
Glucose

The Base of Corn Syrups and of Many Preserves, Jellies and Confections

GLUCOSE, a form of sugar, known as grape-sugar, occurs in nature in sweet fruits, in honey and in all sorts of starchy and saccharin matter. It may be produced from any of these sources, but commercial glucose in the United States is secured almost wholly from corn.

Germany and other European countries manufacture quantities of glucose from potatoes. The industry has been an extensive one over there for more than a hundred years, and the product was first introduced to American manufacturers as an import. Its increasing value within the last forty years has led to the development of the great corn products industry of the United States.

Time was when the use of glucose in food products was attacked. The alleged grounds for the objections were that it was an adulterant with but little food value. That time passed long ago. The government has officially approved it and purchased great quantities of glucose products as food for its armies during the war. Authorities state that



glucose has a food value of approximately seventy per cent of an equal weight of cane sugar.

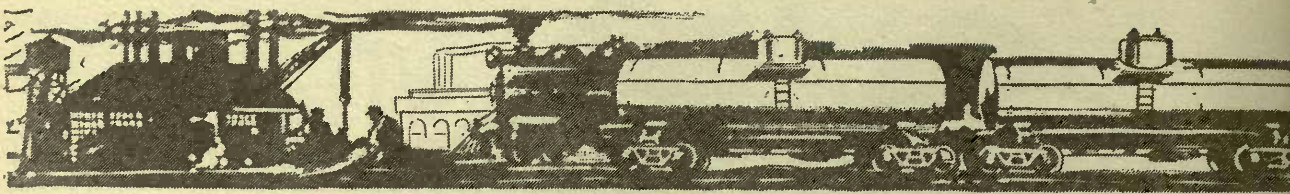
Glucose is the base of all corn syrups. Some corn syrups virtually are pure glucose. The syrups for table use are perfected with combination of pure cane sugar, syrup, maple syrup, sugar refiner's syrup, sorghum or molasses. It also is employed to sweeten wines and beers. The greatest quantities of glucose, however, are consumed in the manufacture of candies. Many candies recommended as the most wholesome sorts largely are glucose. In this use and in the preparation of jellies, preserves and confections, glucose is in the form of corn syrup.

The manufacture of corn syrup is one of the most interesting as well as one of the most important of the food products industries. It consists in separating the starch from the other parts of the grain of corn and then converting that starch into corn syrup or glucose, by means of boiling in a weak solution of muriatic acid. After the process of converting the starch into glucose, the acid is neutralized by the addition of soda ash. The soda and acid form common salt which remains in solution as a component of the corn syrup. The syrup is then boiled down to the consistency desired. It may be boiled to the point where it will congeal into a solid.

The separation of the starch from the other parts of corn is a long process with water. The grains first are steeped in a weak solution of sulphurous acid. Then by grindings and allowing the mass to flow through troughs, the hull,

the germ portion, the gluten and the starch all are isolated. The hulls and the gluten go to make cattle feed. Corn oil is extracted from the germ portions and a valuable meal for cattle is left. The starch, still in solution in water, is poured into copper kettles and converted into corn syrup.

Corn syrup is subject to the same methods of transportation as molasses, except that it is easier to handle because it is lighter. Virtually the entire supply of all manufacturers of glucose products is shipped in tank cars.



CHAPTER XXXVIII

Vinegar

Simple Methods of its Manufacture for the Table, and the Importance of Acetic Acid in Industry

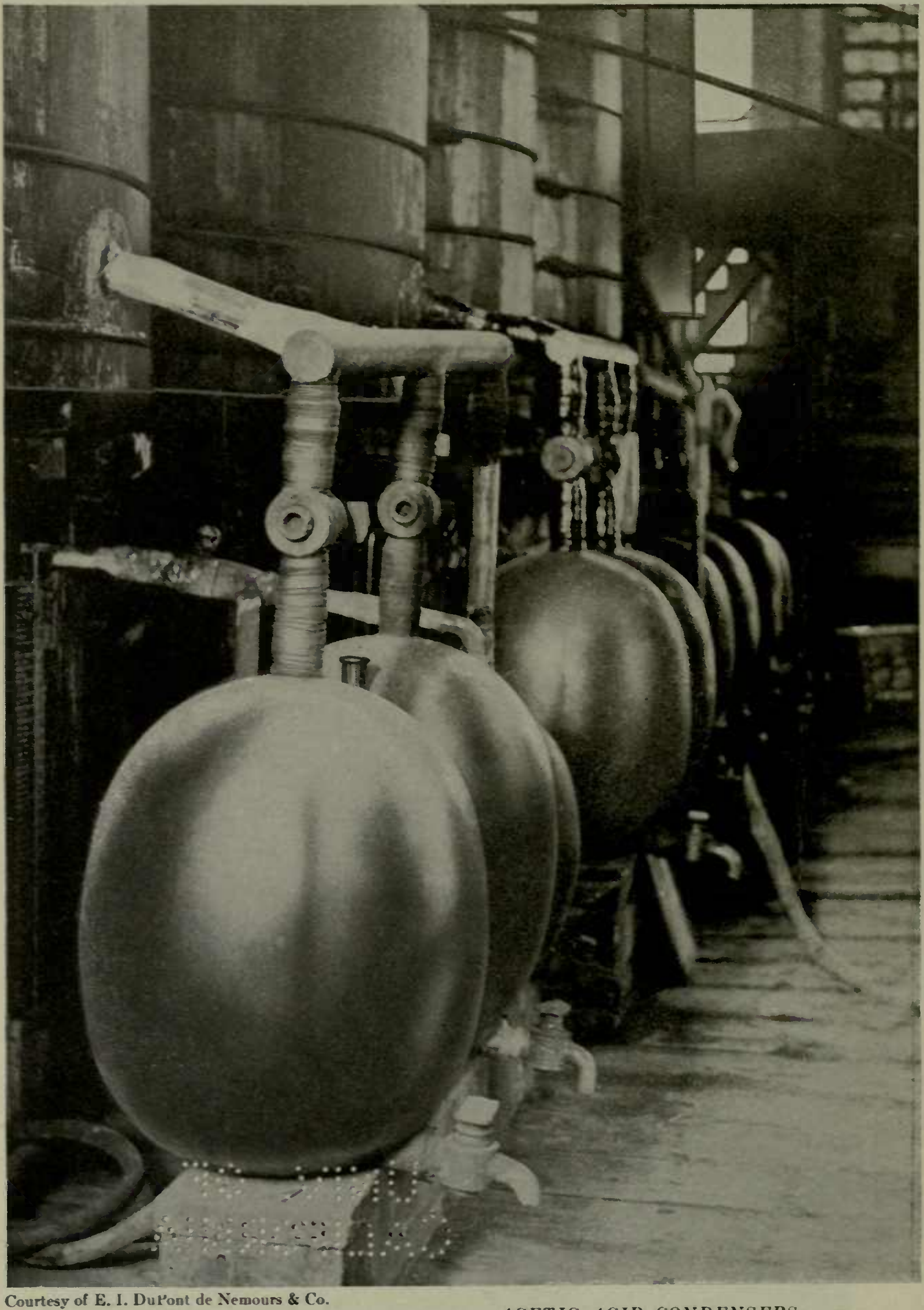
VINEGAR, as we use it on our tables; has been known from the earliest times. It may be made from the must of grapes or the juices of many fruits, but the best and most largely produced variety is from apple cider. Its manufacture, like that of wine, is a process of fermentation. The difference is that with vinegar, after the alcohol has formed, exposure to the air is continued and the alcohol is converted into acetic acid.

Vinegar is acetic acid in a diluted state, with the coloring matter and salts in the fruit juice dissolved. Pure acetic acid may be obtained from any of the wide variety of vinegars. When rectified and purified, it has a use in industry surpassed by only three other acids, sulphuric, muriatic and nitric.

In the chapter on "Alcohol" is described how acetic acid is produced in the destructive distillation of wood. It usually is produced commercially by the interaction of sulphuric acid on acetate of lime. The sulphuric acid and

A MISSOURI APPLE ORCHARD

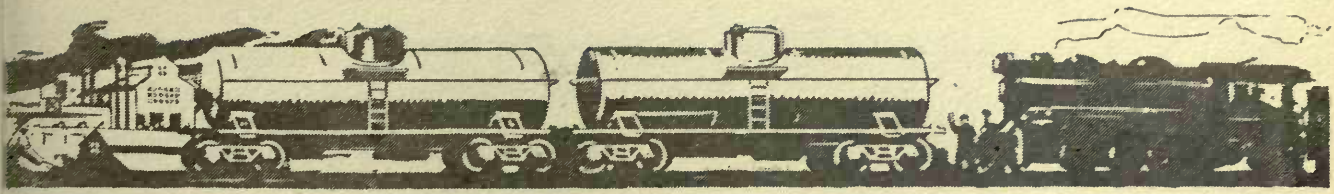
Apples are the principal fruit in the making of jellies, jams and preserves. The great size of the industry is beginning to require tank cars for the shipping of the prepared juices from the orchards to the manufactories.



Courtesy of E. I. DuPont de Nemours & Co.

ACETIC ACID CONDENSERS

Vinegar is diluted acetic acid. Pure acetic acid is one of the most important of industrial acids and is produced on a large scale by the action of sulphuric acid on acetate of lime. The picture shows lead condensers in which the vaporized acid is reduced to a liquid state.



acetate of lime are mixed in large cast iron stills and heat is supplied by means of steam coils. Exhaust pumps produce a vacuum, and the crude acetic acid vaporizes and is collected in lead condensers. The rectifying and purifying processes reduce it to a solid, a leafy, crystalline mass with a pungent odor.

Probably the most important use of acetic acid is in the corrosion of white lead in the Dutch process. It is employed on a large scale in cotton printing, bleaching and dyeing. In medicine it is applied as a caustic for corns, and, in a dilute state, to bathe the skin in fever. It also is used to prepare acetone, as was explained in an earlier chapter.

The time-honored uses of vinegar on the table and in pickling and preserving fruits and vegetables are well known. The apple vinegar for these purposes is manufactured by two simple processes—the rolling generator and the slow barrel process. This vinegar is prepared to a great extent on the farm, where the apple orchards are easily accessible.

The apparatus for the first process is a barrel with a slatted partition running lengthwise, dividing the barrel into slightly unequal parts. In the smaller compartment beech shavings, corn cobs or some similar substance, thoroughly saturated with good strong vinegar, are placed. On the same side small oblique air-holes are bored in the ends of barrel. The whole interior of the barrel is thoroughly rinsed with good vinegar. The air-holes are plugged and the barrel about half filled with apple cider. Several quarts of vinegar are added. The bunghole then is

closed and the barrel, which lies on its side upon a trestle, is turned over so that the cider will run into the shavings. It then is righted, the air-holes unplugged, and the cider allowed to drip from the shavings. The rolling is repeated several times a day.

The slow barrel process is simpler, and, as its name implies, requires more time. The cider is allowed to ferment to the alcoholic point in wooden casks, and then it is transferred to a barrel that has been thoroughly soaked with strong vinegar. The new barrel is filled to within a few inches of the bunghole and a few quarts of vinegar, with a little "mother" in it, are added. The bunghole is left open to admit air and the content watched to determine acetification. If allowed to remain too long, the vinegar begins to lose its strength, the acid in turn being destroyed.

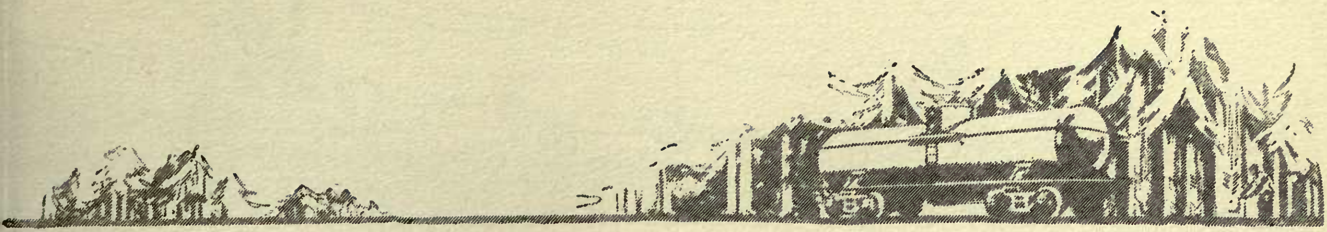
Vinegar must not be hauled in steel cars. It is shipped in tank cars with the tanks made of wood and mounted on flat cars.

THROUGH SNOW AND STORM THE TANK CAR "CARRIES ON"

Commercial liquids are as essential to the industrial and domestic life of the country as coal. The need of faithful, reliable tank car service for their shipment has come to be imperative.

HARVESTING GRAPES IN CALIFORNIA

California developed a great wine industry. The vines that produce the famous wines of Europe have been successfully adapted so that we now can produce an equally choice variety of domestic wines.



CHAPTER XXXIX

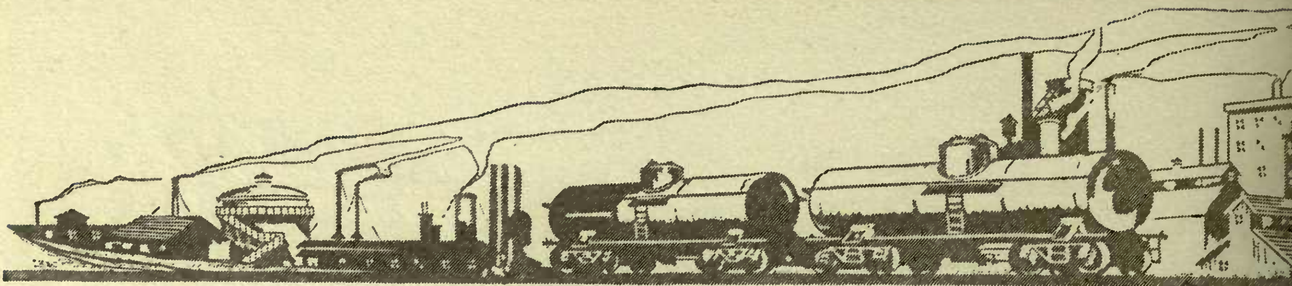
Wine

The Art of Fermenting Wine and a Description of the More Famous Kinds

WE need not turn to prosaic historical works to learn of the early use of wine. Mention of it runs through the inspired books of the Bible; the finest gem of pagan literature largely is devoted to praise of this spirit—The Rubaiyat of Omar Khayam.

The ancient Egyptians and Greeks attributed its introduction to the gods. The Hebrews ascribed its discovery to Noah. Research has developed that the first knowledge of wine as a pleasing beverage probably came by accident, through the fermentation of the juice of bruised wild grapes. Anyway, the making of wine today virtually is the same as in prehistoric times, though the record of additions of spices and the like in early times indicates that the quality was not so good as it is now.

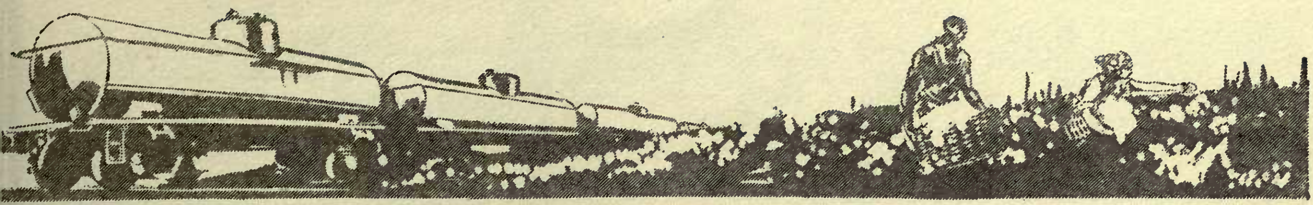
When we speak of wine, we mean the fermented juice of the grape. Other wines are expressed by a prefix of the name of the fruit from which the juice is extracted. The locali-



ties of its manufacture always have been determined by the climate and soil most conducive to the growth of the grape. Quality and soil also determine the quality of the wine, for these are the elements that give the grapes their fragrance and bouquet. Thus it is that the wines of Germany, and more especially of France, long have held their place as favorites.

The greatest wine producing section of America is in California. There 280,000 acres are under vines, and the annual production is approximately 30,000,000 gallons. The finest varieties of vines from along the Rhine and from Champagne and other provinces of France have been transplanted and developed and the modern methods of conducting fermentation employed in California. New York and Ohio follow in wine production, their similarity in climate to the best wine producing provinces of France enabling them to compete in champagnes, clarets, and so forth. The total annual output of the United States is something like 50,000,000 gallons. Though the figures of California's production show it to be the far greater proportion, there are some 75,000 acres of land in New York in vines, and each year approximately 5,000,000 gallons of wine are made.

The process of manufacture is simple. The grapes are gathered by hand and carried to the press. In the making of white wine, the stems and hulls are removed from white grapes, while in the manufacture of red wine, entire red grapes are used, including the hulls, as the color of red wine comes from the hulls. Then the juice, or must, as it is

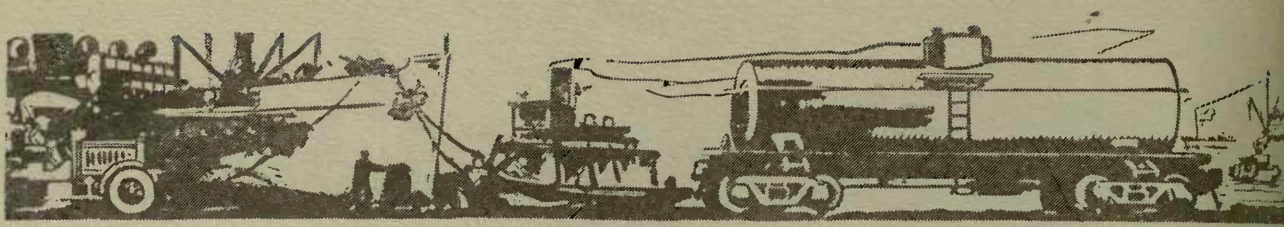


known, is expressed and exposed to the process of fermentation.

Unlike the manufacture of beer and other spirits, no yeast is added to begin the process. The must is placed in wooden casks, and living yeast cells in it begin to act on the sugar and produce fermentation. The art required, as the process continues, largely is clean and careful handling. There follows "racking," or the separation of the bright wine from the deposit, and "fining," which is the elimination of the suspended matter. After a period, varying from two to four years, according to the sort of wine being made, the wine is ready for bottling. Some wines, like port, are kept in wood for many years and its quality thereby changed from year to year.

Wines got their names from the districts and countries that first gave the distinct types to the world. There are hundreds of varieties, ranging in color from purple to white, and in taste from sweet to dry, dry meaning sour. Almost any degree in the range of taste may be secured by blending wines. There is temptation, of course, to do this by artificial methods, but the matter is regulated by law.

The names of wines have come to represent types, and in this country their European names are largely followed. Thus we have champagne, claret, burgundy and sauturnes from France; from Italy, Lacrima Christi, Marsala and others; from Germany, Moselle and Rhine wines; from Spain, madeira and sherry; from Portugal, port. A famous type produced in the United States, in Ohio around Lake Erie, is "sparkling catawba."



The cheapest and most largely consumed of all wines are simple red wines and white wines, both sweet and dry. They are the light wines that are consumed in such quantities by the peasants of Europe. In many districts the wines take the place of water for drinking purposes.

Here follows a description of each of the wines above mentioned, since they are among the most popular and better known of the many sorts:

Champagne—Gold and red; sparkling, dry and sweet.

Claret—Red; astringent and sweet.

Burgundy—Red and white; still and sparkling; dry and slightly astringent.

Sauturnes—White; still and dry.

Lacrima Christi—Red; sweet and delicate.

Marsala—Similar to Madeira.

Moselle—White; still and sparkling; soft, delicate, aromatic.

Rhine Wine—Yellow; still and sparkling, dry, aromatic.

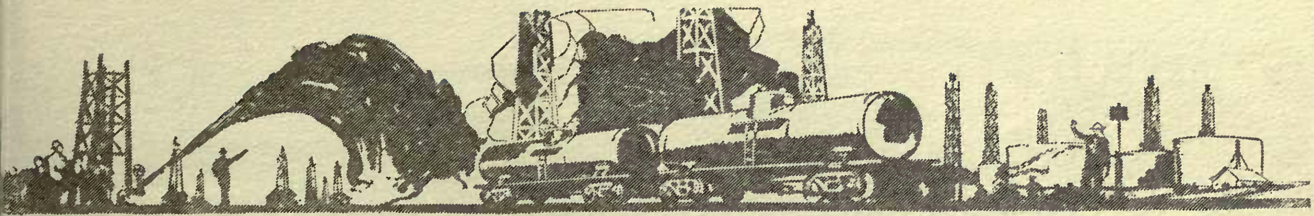
Madeira—Red and white; still, dry, delicate.

Sherry—White; still, strong, spirituous.

Port—Dark purple and white; still, sweet, astringent.

Catawba—White and straw; still and sparkling; dry, sweet.

Besides its use as a beverage and in cooking, quantities of wine are employed in the manufacturing of medicines.



California wine especially is handled in Standard Tank Cars. In shipping, the wine must be kept at an even temperature, not being allowed to get too cold. The cars are covered with mineral wool, with a wood lagging over the wool to keep it dry. Inside the tanks are covered with paraffin to keep the wine from contact with the steel.

The wine industry has been somewhat demoralized by the prohibition amendment to the constitution, but many producers have continued to market wine as a beverage by dealcoholizing it.

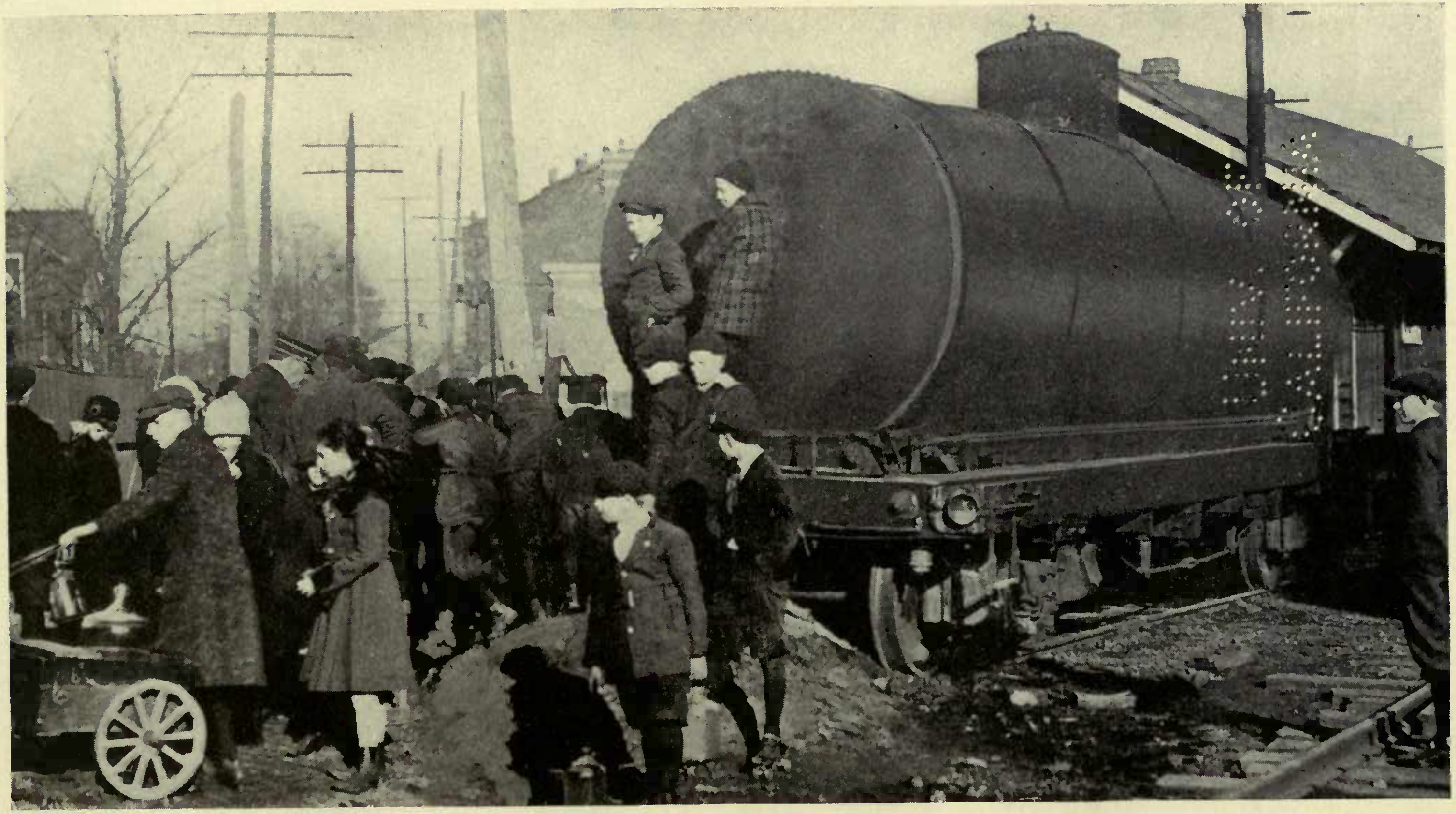
CHAPTER XL

Water

How the Tank Car Answers the "S. O. S." Call for Water

AS among mankind, he serves best who serves simplest, no service of the tank car is more appreciated than its transport of water. Water for man and beast in arid deserts; water that gives life to plants through irrigation; water from great rivers to towns and villages that have suffered a long drought—these are functions in which there is no substitute for the tank car.

Pure drinking waters are made easily available to communities where the water happens to be impure. Spring waters always have a wide market, and they can be shipped in great quantities in tank cars. Construction work in dry countries, like railroad building, can proceed without fear of interruption for lack of drink. Armies must have water even if they can not get food. The increasing demand for Standard Tank Cars for water is a climatic proof of their worth.

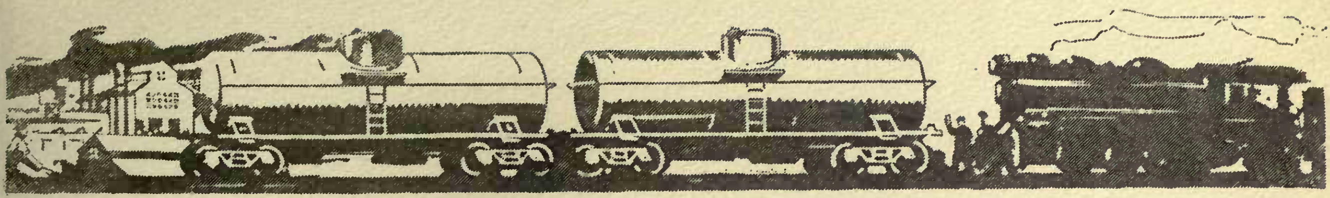


WHEN NORFOLK, VA., WENT DRY

Prohibition? No! Norfolk ran out of water in January, 1920, from lack of rainfall. The photograph here reproduced shows how tank cars were used to supply the people. A daily ration of five gallons was issued to each family.

STANDARD TANK CAR COMPANY WORKS AT SHARON, PA.

Not only does the Standard Tank Car Company build more tank cars than any other company in the world, but also it represents the most complete organization in plant and equipment and the most modern methods in engineering and manufacturing practice.



CHAPTER XLI

Ideals of Business Expressed in Standard Tank Cars

WITH all this story, the uses of tank cars have not been exhausted. So important an adjunct always must be prepared to respond to the growth of industries. The introduction of their use to foodstuffs opens up a great and wide new field. But the purpose of this book is not a recitation of the mere mechanical functions of the tank car. Its place in American life is bigger than that.

Art and literature follow an ideal to enrich life with beauty and truth. The law would maintain justice in men's dealing with one another. Medicine seeks to relieve human suffering. Now business, elevated from a history of being an unworthy vocation, has found an equally high purpose in rendering unto mankind utilities.

Economists, who have thought out the science of it, say there are three utilities created by business. They are form utilities, which is manufacturing; time utilities, which consist in holding goods or property from a period when the supply is great and the demand low until a date when the opposite is true; and place utilities, which is transportation.

We have shown you that tank cars create great place utilities, and we feel that we may justly place the ideals of the Standard Tank Car Company along with those of the arts and the professions.